



Niagara Street Phase II Green Infrastructure Report

Prepared by Bergmann Associates and Joy
Kuebler Landscape Architect for the City of
Buffalo and the Buffalo Sewer Authority

June 2015



Niagara Street Phase II Green Infrastructure Report
Niagara Street Phase II Project, Erie County, City of Buffalo

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This Report has been prepared by Bergmann Associates, with information provided by Joy Kuebler Landscape Architects, to describe and document the green infrastructure elements that have been included within the Niagara Street Phase II Project.

I. INTRODUCTION

A. PROJECT DESCRIPTION

The Niagara Street Phase II project, between Porter Avenue and Virginia Street, is located in Erie County, adjacent to downtown Buffalo (Figure 1). Niagara Street is a west side signature gateway for traffic exiting Interstate 190 heading into the downtown area that radiates northwesterly from the center of the City at Niagara Square where City Hall is located. Phase II is a continuation of the Phase I Project that extends from City Hall north to Virginia Street. The project corridor encompasses a distance of approximately 3,500 feet or 0.65 miles, from the end of Phase I roughly at Virginia Street north to Porter Avenue at Prospect Park (Figure 2). The existing poor and dilapidated pavement, curb, signage, signaling and striping conditions will be improved to increase overall safety and quality of life for area residents and visitors. Improvements will generally include the milling and overlay of roadway pavement and select curb and full sidewalk replacement, with provisions for landscaping amenities, traffic calming measures and storm water management facilities to reduce the volume of storm water entering the combined sanitary/storm water sewer system.

B. EXISTING (PRE-IMPROVED) CONDITIONS

The project corridor is a well-developed urban arterial with commercial, educational, medical, retail business and multi-family residential housing. With few exceptions, development occurs within a shallow setback to the Right-Of-Way (ROW) of Niagara Street. The project area generally drains to the south as it approaches City Hall (and the north limit of Niagara Street Phase I Improvements). There is approximately 40 feet of elevation difference between Porter Avenue to the north and Virginia Street to the south. Intersecting side streets on the east side drain toward Niagara Street, and the corresponding west side streets drain westerly away from Niagara Street. Within the limits of the project corridor (ROW to ROW) exists approximately 320,606 SF (7.4 acres) of impervious surface. For the purposes of this report, it is assumed that no pervious surface exists within the corridor. The few grass areas and tree pits that do occur are highly compacted and are not assumed to infiltrate much surface runoff.

C. PROPOSED (POST-IMPROVED) CONDITIONS

The proposed project includes the rehabilitation of the existing roadway (mill and overlay) and full sidewalk replacement with bump outs, tree pits and landscaped areas. Where possible, excess sidewalk has been replaced with turf, new tree pits, or rain garden landscaped beds in order to reduce the overall amount of paved impervious surface area within the project corridor. In addition, structural soil and open-graded permeable aggregate will be placed under much of the new sidewalk and bump out areas in order to capture and store storm water. The Buffalo Sewer Authority (BSA) has a goal for its green infrastructure to capture 100 percent of the 90% rainfall event for the entire project corridor. The project has been designed to capture and store all surface runoff entering and generated from within the project corridor. See Appendix A, Green

Infrastructure Streetscape Plan for an overall view of the proposed green infrastructure improvements.

II. GREEN INFRASTRUCTURE

A. NIAGARA STREET GREEN INFRASTRUCTURE

Various methods of green infrastructure were assessed for use on the Niagara Street Phase II Project. First and foremost was the goal to reduce the amount of impervious surface area within the public ROW in order to decrease the resultant rainfall runoff. Green space was increased in several ways: by reducing the width of over-wide sidewalks; by increasing the size of existing tree pits; and by reducing the roadway width with new landscaped or lawn bump outs. Rain gardens and non-lawn landscaped areas were included only when an adjacent land owner agreed to maintain them.

To capture the runoff volume generated by the reduced impervious area, open-graded permeable aggregate will be used underneath the new sidewalk and bump out areas. Within new tree pits and adjacent to existing trees to remain, structural soil will be used in lieu of the open-graded permeable aggregate to facilitate tree growth. Structural soil exhibits the same structural characteristics as the open-graded permeable aggregate needed to support load-bearing infrastructure (pavements) with the added benefit of being able to support vegetative growth. These materials will be placed to an approximate depth of 3 feet to create an underground reservoir for storm water storage. Catch basins located within the roadway will direct water into the open-graded permeable aggregate and structural soil storage areas beneath the sidewalk. Curb cuts at rain garden locations will also accept surface runoff from the roadway directly into the rain gardens where it will be stored while it infiltrates into the open-graded permeable aggregate and structural soil reservoirs below. The new sidewalk areas will drain into trench drains that are tied directly into the permeable subbase, or into adjacent tree pits, landscaped beds, or turf areas. Open-graded permeable aggregate will also be used under the rain gardens and beneath some of the landscaped and lawn areas. Perforated underdrain within these storm water reservoirs will convey un-infiltrated storm water from the underground storage areas to the combined sewer system in the event the reservoir storage is at capacity. For typical cross sectional details refer to Appendix B.

No porous pavement types were utilized in this project.

B. CAPTURE AREA

The capture area of the project corridor within the ROW limits was determined to be 7.4 acres of contiguous impervious surface from Porter Avenue south to just north of Virginia Street (the ending limit of Phase I). Recent topographic mapping generated for this project was utilized to determine drainage patterns within the corridor.

The capture area was assumed to be from ROW to ROW throughout the length of the project corridor and included minor areas at the side street intersections that drain into the project corridor. Existing tree pits and curb lawns were assumed to be impervious due to years of compaction or significant root development. Appendix C, Drainage Area Plans, illustrates the capture area limits per block for the project corridor.

C. CAPTURE AREA SIZING AND CAPACITY

The New York State Stormwater Management Design Manual (January 2015) provides guidance on the required storage area needed to capture the BSA's goal of 100% of the 90% rainfall event. The original project capture area of 7.4 acres was reduced to 6.8 acres (an 8.1% reduction in impervious area) with the conversion of paved area into lawn or landscaped area with the new streetscape design. The new capture area of 6.8 acres will generate approximately 0.46 acre-feet of storm water runoff at the 90% rainfall event. Therefore, along the length of the project corridor, a minimum of 0.46 acre-feet of storage must be provided to meet the BSA capture goal.

As already noted, underground storage will be provided by the approximately 3-feet deep layer of open-graded permeable aggregate and structural soil. The assumed porosity of both mediums is 20%. Given the volume of both the open-graded permeable aggregate and structural soil used in the project, this equates to approximately 0.68 acre-feet of storage available. Therefore the proposed storm water reservoir is capable of storing the required volume of 0.46 acre-feet. In fact, the proposed storm water reservoir is able to accommodate almost 1.5 times the required volume. This additional storage area is beneficial to allow for potential runoff from areas outside the ROW that were not mapped as part of this project as well as to accommodate for some siltation and resulting decreased permeability of the subbase material that may occur over time. Refer to Appendix D, Storm Water Storage Area Sizing Calculations, for detailed storage area sizing calculations provided by the Niagara Street Phase II design.

TABLE II – 1
STORAGE AREA

Storage Area Required		0.46 ac-ft
Storage Area Provided		0.68 ac-ft
Structural Soil	0.29 ac-ft	
Open-Graded Permeable Aggregate	0.39 ac-ft	

100% of the 90% rainfall event will be collected and conveyed to the green infrastructure system.

III. GREEN INFRASTRUCTURE MAINTENANCE

A. CONTRACTOR RESPONSIBILITIES

As part of the green infrastructure installation, the contractor will be expected to test the permeability of permeable aggregate and structural soil in four sample locations for each material after placement and compaction to ensure adequate drainage of in-place material.

Once all special aggregate subbase layers have been placed to their proper depths and compaction densities (and tested successfully), and all sock-filled underdrain pipe has been installed and connected to their respective drainage structures, the green infrastructure system shall be tested prior to placement of any final top surfaces. This testing is to ensure the free-flow of water from the open-graded permeable aggregate or structural soil into the underdrain and drainage structure overflow system.

The installation of landscaping features including all growing media, mulch, trees, shrubs, ornamental grasses, perennials, groundcover, and sod shall be performed by a Landscape Contractor licensed to do business in the City of Buffalo. The successful bidder on this project must provide proof of being licensed as a City of Buffalo Landscape Contractor to execute the contract and maintain said license throughout the project.

The licensed Landscape Contractor who installs all landscaping will be expected to enter into a maintenance contract with the Buffalo Sewer Authority to provide maintenance of all landscaping features placed under the construction contract. This Maintenance Contract will have a period of two (2) years from the date of Construction Contract acceptance. A more detailed description of the green infrastructure systems and landscaping maintenance and testing requirements that were included as part of the construction contract for Niagara Street Phase II can be found in Appendix E.

B. CAREGIVER RESPONSIBILITIES

As noted earlier, rain gardens and/or landscaped green areas (other than turf or lawn) were included within the project corridor only when an adjacent property owner agreed to assume care and maintenance responsibilities. Success of the planted material is vital in the performance of rain gardens to capture, store, and treat storm water before it infiltrates naturally into the ground or makes its way to the overflow storm system. The two (2) year maintenance contract by the installing Landscape Contractor is envisioned to get the rain gardens established, healthy and thriving before the adjacent property owner takes over maintenance responsibilities. Once established, periodic removal of trash and debris (at least once a month and immediately following a major rainfall event) by the responsible landowner, along with a more scheduled maintenance regime for the plant material, will be required. Inlets and/or concrete dissipators leading into the rain gardens should be kept clear of debris and sediment, and shredded hardwood mulch should be replaced over bare or eroded soil. Refer to Appendix F for a complete maintenance guide and seasonal task list expected to be performed by the agreeing landowner.

IV. PROBABLE COSTS

The green infrastructure incorporated into the Niagara Street Project Phase II consists of underground storage reservoirs of open-graded permeable aggregate and structural soil. When not covered by paved surfaces, the underground reservoirs are landscaped with rain gardens and lawn areas. Successful bidder unit bid prices are noted below in Table IV-1 for the open-graded permeable aggregate and structural soil material.

TABLE IV – 1
GREEN INFRAStructure SIZING, CAPACITY & ESTIMATE COST

	QTY	BID UNIT COST	BID COST	STORAGE CAPACITY	COST PER AC-FT STORAGE
Structural Soil*	2370 CY	\$75/CY	\$177,750	0.29 ac-ft	\$605,000
Open-Graded Permeable Aggregate*	3120 CY	\$60.50/CY	\$188,760	0.39 ac-ft	\$488,033
* Assumes 20% porosity					



Project Limits

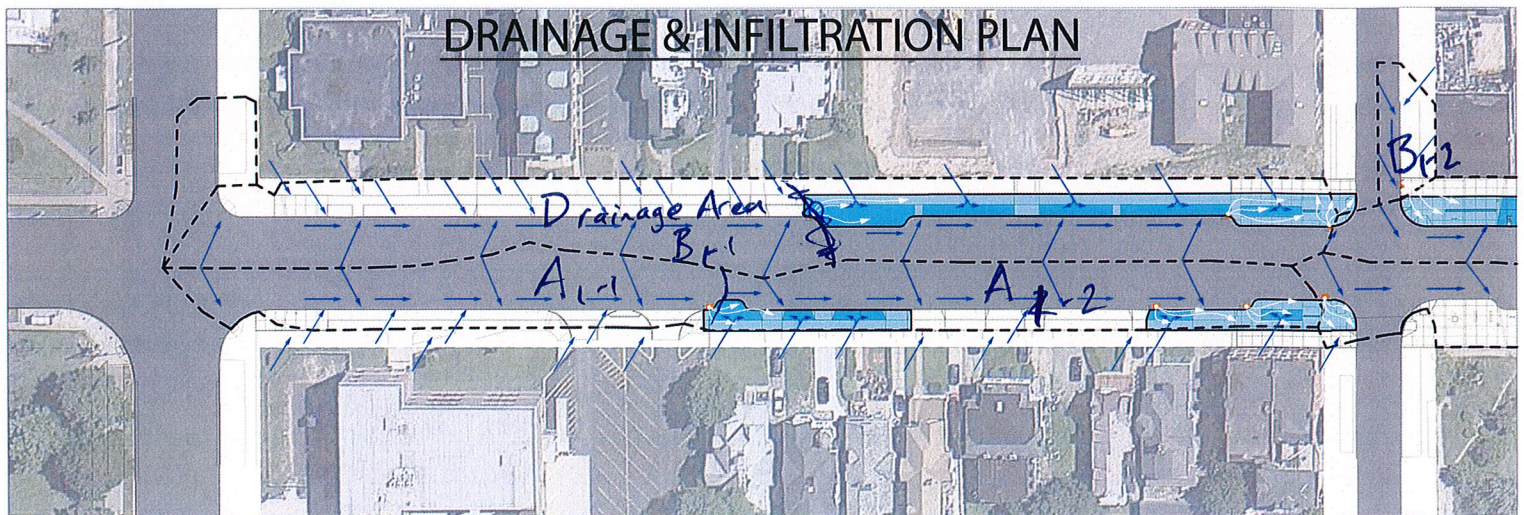
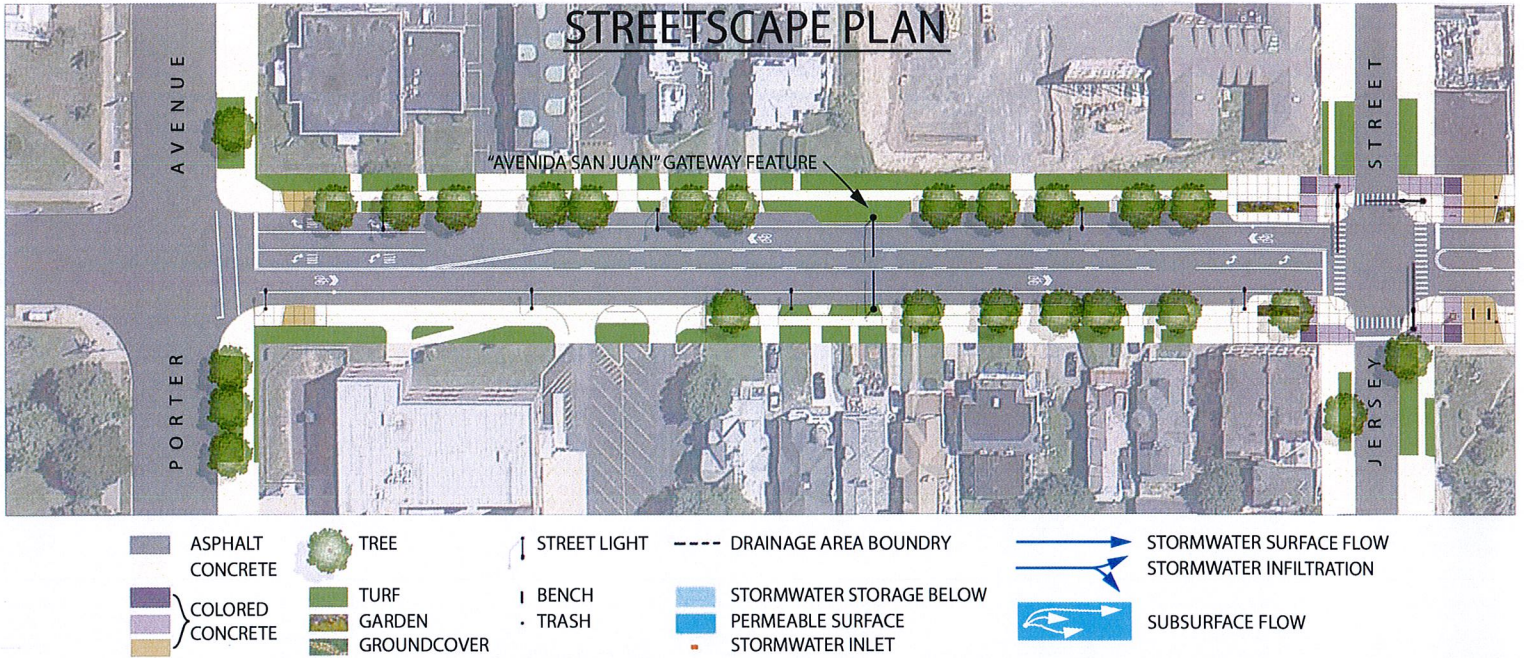
LOCATION MAP
FIGURE 1



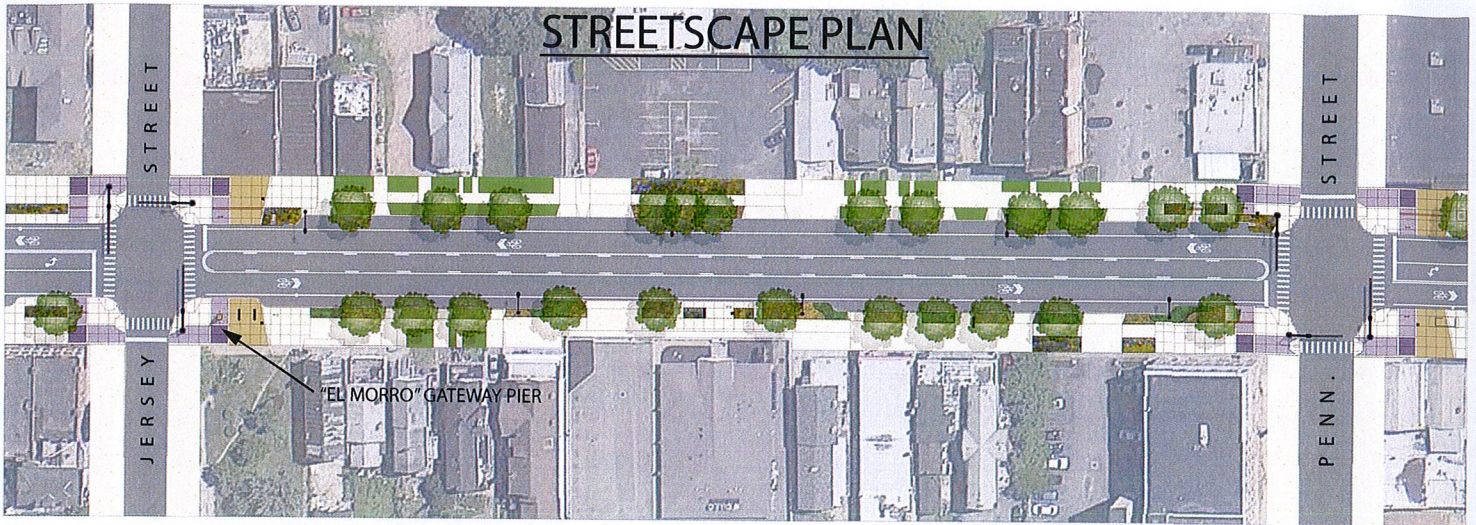
CONTEXT MAP
FIGURE 2

Appendix A

Green Infrastructure Streetscape Plan

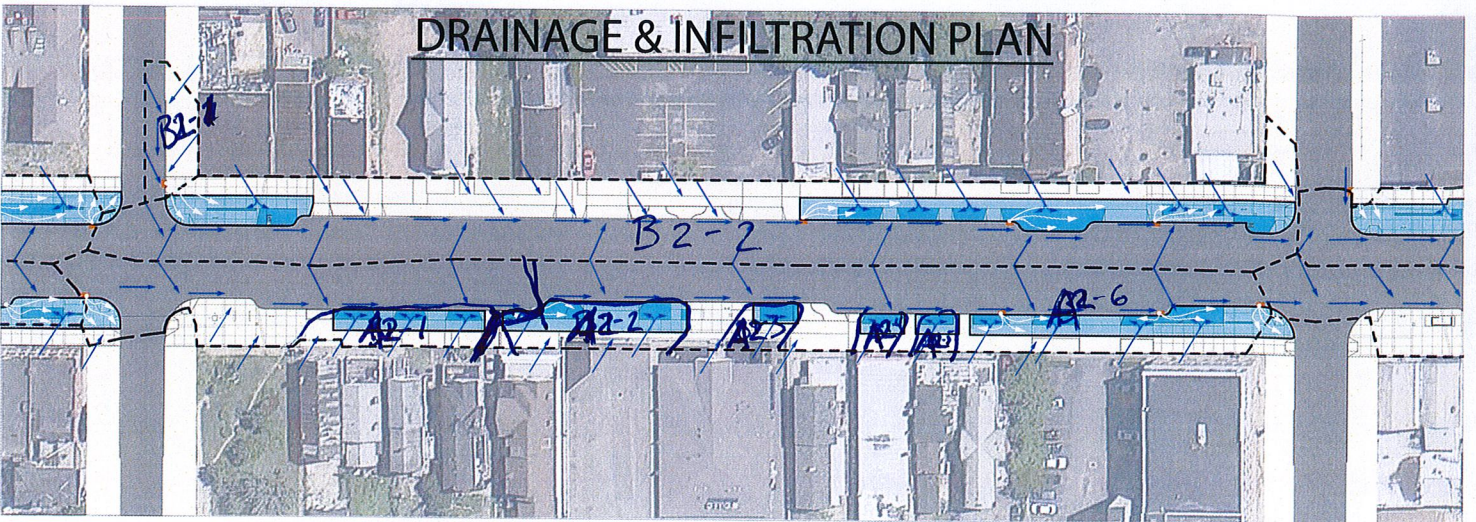


STREETSCAPE PLAN



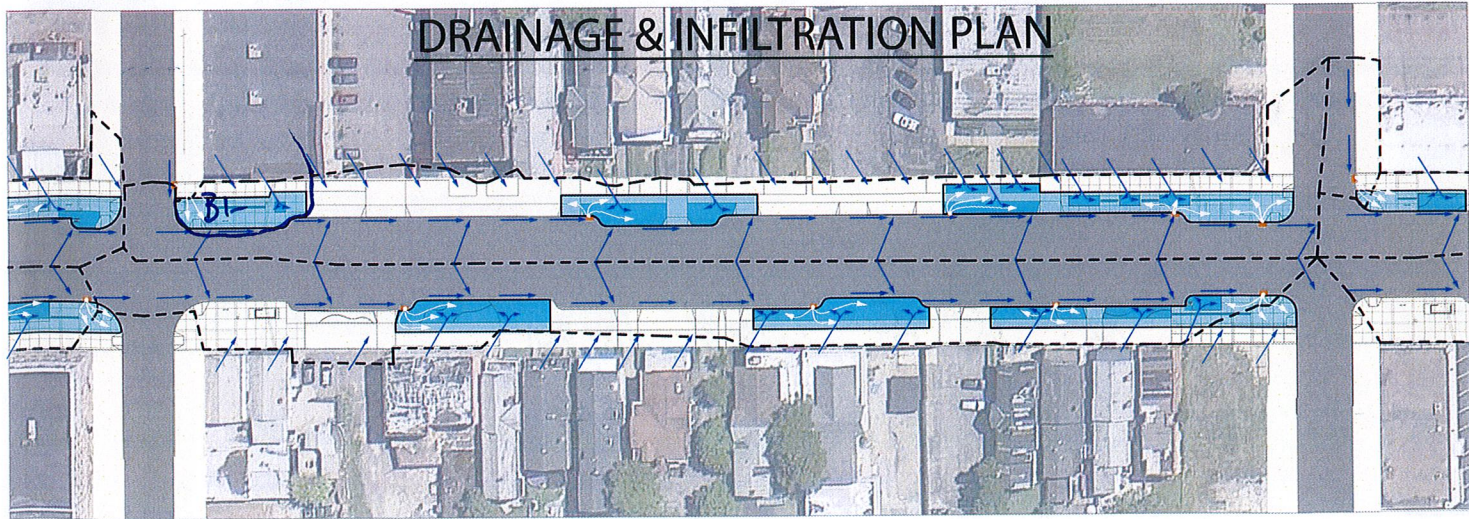
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|---------------------|-------------|--------------|---------------------------|-------------------------|
| ASPHALT
CONCRETE | TREE | STREET LIGHT | --- DRAINAGE AREA BOUNDRY | STORMWATER SURFACE FLOW |
| COLORED
CONCRETE | TURF | BENCH | SPECIAL AGGREGATE BELOW | STORMWATER INFILTRATION |
| | GARDEN | TRASH | PERMEABLE AGGREGATE BELOW | SUBSURFACE FLOW |
| | GROUNDCOVER | | INLET | |

DRAINAGE & INFILTRATION PLAN





- | | | | | |
|------------------|-------------|--------------|------------------------------|-------------------------|
| ASPHALT | TREE | STREET LIGHT | ----- DRAINAGE AREA BOUNDARY | STORMWATER SURFACE FLOW |
| CONCRETE | | | | STORMWATER INFILTRATION |
| COLORED CONCRETE | TURF | BENCH | STORMWATER STORAGE BELOW | |
| | GARDEN | TRASH | PERMEABLE SURFACE | SUBSURFACE FLOW |
| | GROUNDCOVER | | STORMWATER INLET | |

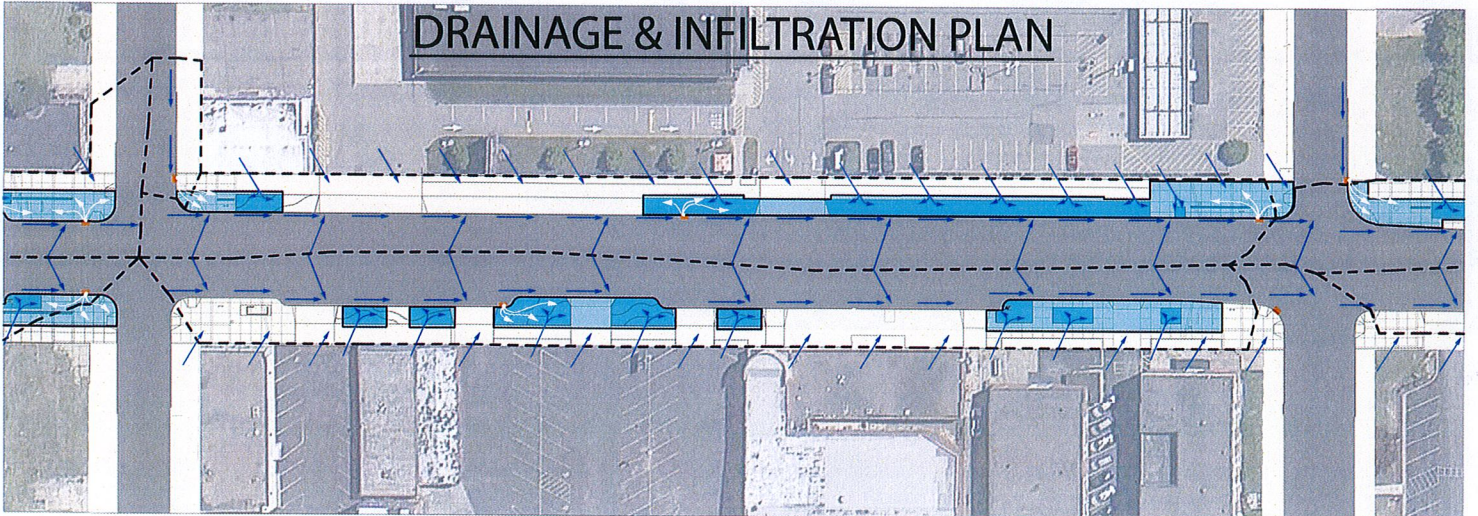


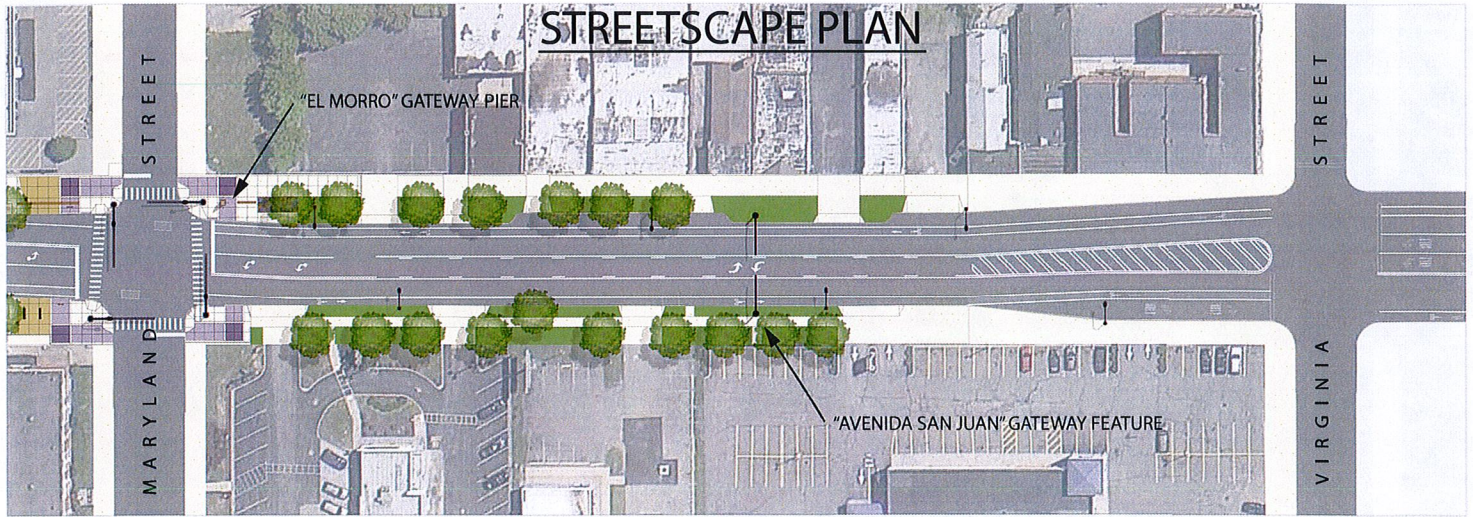
STREETSCAPE PLAN



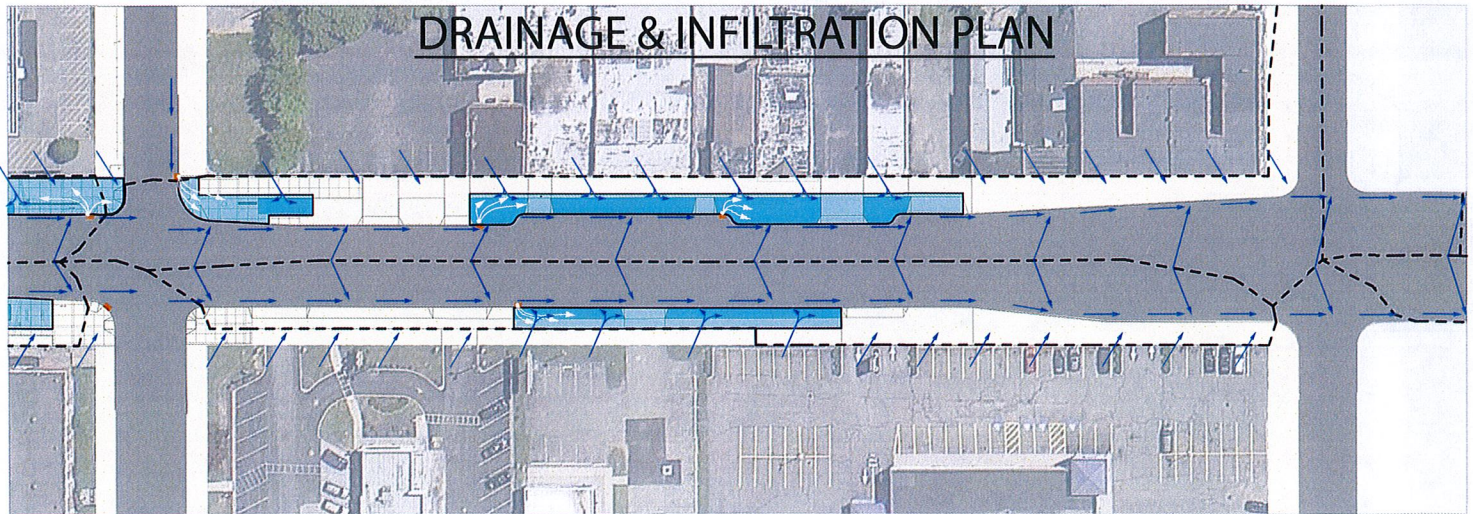
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|---------------------|-------------|--------------|----------------------------|--|
| ASPHALT
CONCRETE | TREE | STREET LIGHT | --- DRAINAGE AREA BOUNDARY | STORMWATER SURFACE FLOW
STORMWATER INFILTRATION |
| COLORED
CONCRETE | TURF | BENCH | STORMWATER STORAGE BELOW | SUBSURFACE FLOW |
| | GARDEN | TRASH | PERMEABLE SURFACE | |
| | GROUNDCOVER | | STORMWATER INLET | |

DRAINAGE & INFILTRATION PLAN



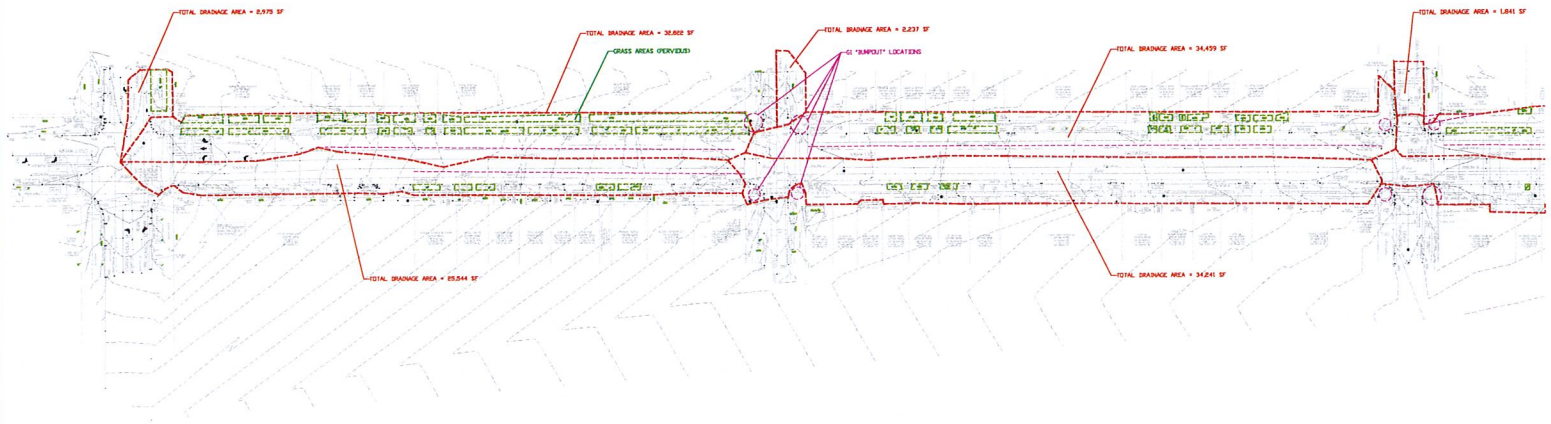


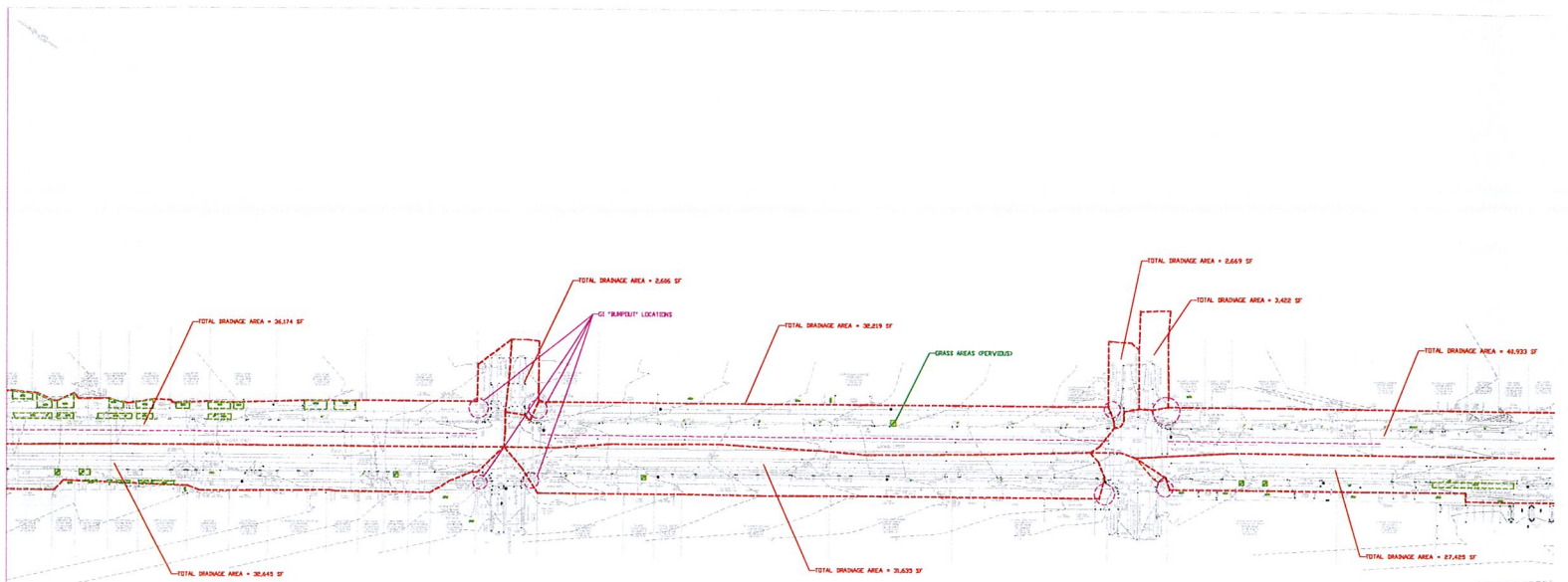
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|------------------|--------------|--------------|----------------------------|-------------------------|
| ASPHALT | TREE | STREET LIGHT | --- DRAINAGE AREA BOUNDARY | STORMWATER SURFACE FLOW |
| CONCRETE | TURF | BENCH | STORMWATER STORAGE BELOW | STORMWATER INFILTRATION |
| COLORED CONCRETE | GARDEN | TRASH | PERMEABLE SURFACE | SUBSURFACE FLOW |
| | GROUND COVER | | STORMWATER INLET | |

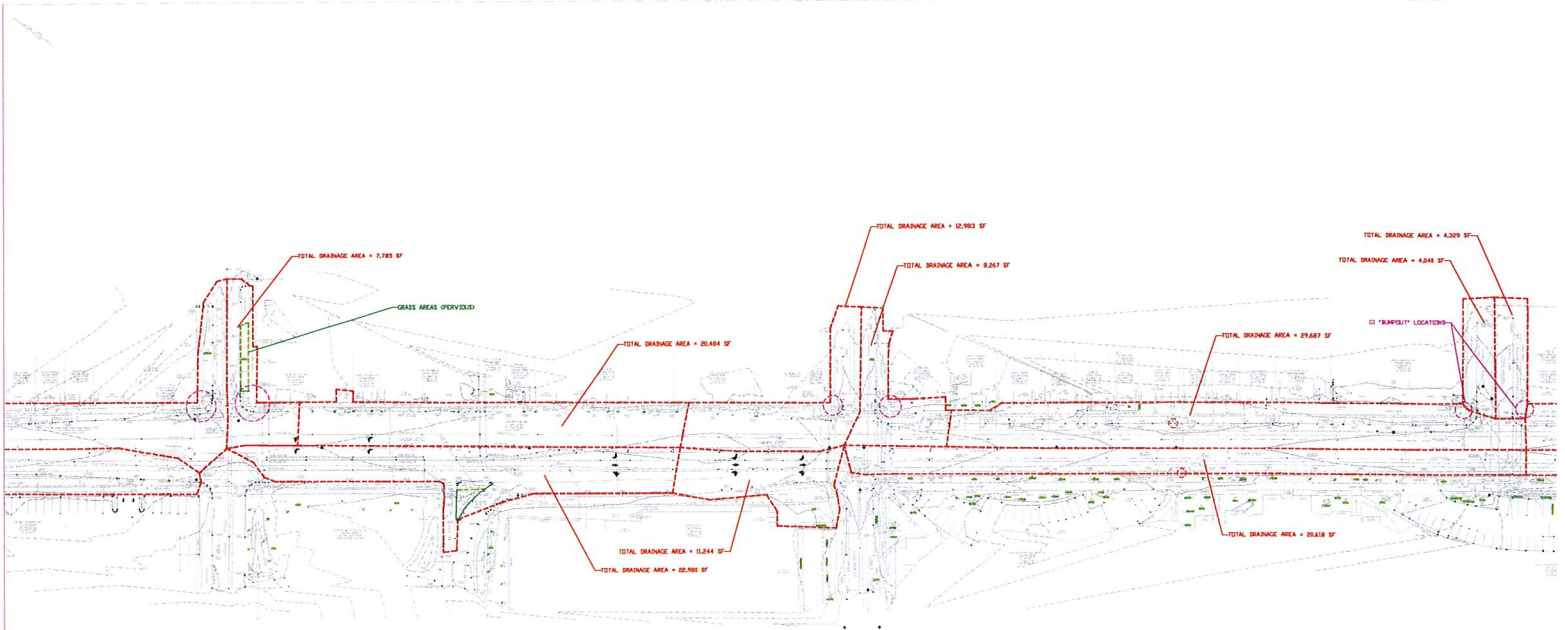


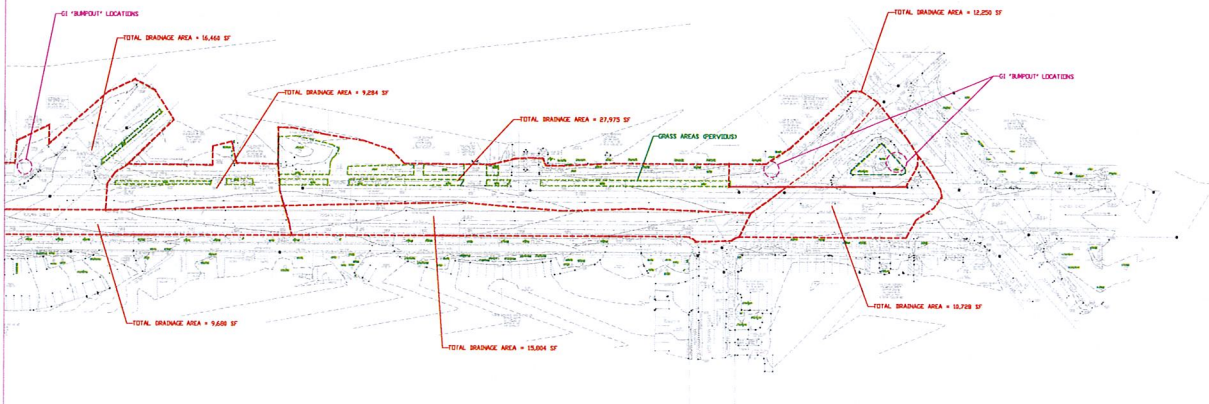
Appendix C

Drainage Area Plans (Capture Area Limits)









Appendix D

Storm Water Storage Area Sizing Calculations

Appendix B

Typical Green Infrastructure Cross Sections

Niagara Street Improvements Phase II Virginia St. to Porter Ave.



JOY KUEBLER
LANDSCAPE ARCHITECT PC

65 Zimmerman Street
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NO.	DATE	REVISION	BY	CHKD
1				



SITE DETAILS

NOTE: Unpublished alteration or addition to this drawing is in violation of the New York State Education Law Article 141, Section 7206.

Project Manager	AK
Design	AK
Client	AK
Contract	AK
Drawings	AK
Approval	AK
Scale	AS SHOWN

Project Name: _____
Drawing Name: _____

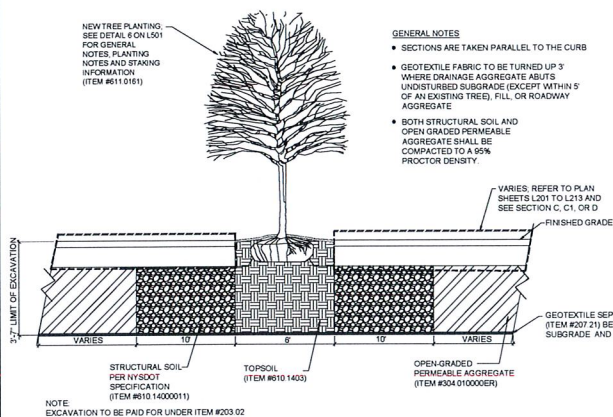
L503 94 of 119

GENERAL NOTES

- REMOVAL AND RECONSTRUCTION APPLIES TO ALL SIDES OF EXISTING TREES
- SECTIONS ARE TAKEN PARALLEL TO CURB
- GEOTEXTILE FABRIC TO BE TURNED UP 3' WHERE DRAINAGE AGGREGATE ABUTS UNDISTURBED SUBGRADE (EXCEPT WITHIN 5' OF AN EXISTING TREE)
- BOTH STRUCTURAL SOIL AND OPEN GRADED PERMEABLE AGGREGATE SHALL BE COMPACTED TO A 95% PROCTOR DENSITY

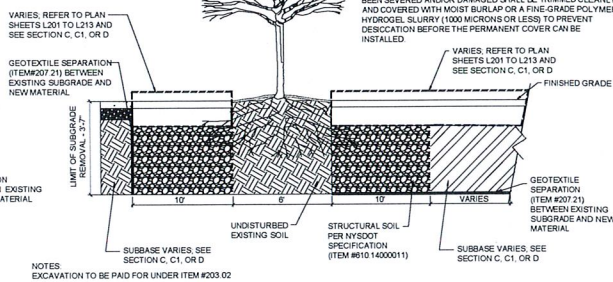
REMOVAL NOTES

- REMOVE CONCRETE AND SUBBASE IN THEIR ENTIRETY
- AIRSPADE EXISTING SUBGRADE MATERIAL TO LIMIT OF SUBGRADE REMOVAL, IN ORDER TO LEAVE EXISTING ROOTS INTACT
- THE CRITICAL ROOT RADIUS (CRR) FOR AN INDIVIDUAL TREE CAN BE DETERMINED BY CREATING A CIRCLE CENTERED ON THE TRUNK THAT EXTENDS 1-1/2 FEET FOR EVERY INCH OF TREE DIAMETER MEASURED AT DIAMETER BREST HEIGHT (DBH). FOR INSTANCE A 10-INCH TREE (DBH) WILL HAVE A CRR EXTENDING 15 FEET AWAY FROM THE TRUNK OF THE TREE. NO ROOTS SHALL BE CUT WITHIN THE CRR WITHOUT THE SPECIAL PROTECTION MEASURE AS DESCRIBED BELOW
- ONCE EXPOSED, ROOTS MUST BE INSPECTED BY THE PROJECT ARBORIST, TO DETERMINE WHICH, IF ANY, REQUIRE REMOVAL. ROOT PRUNING PROCEDURES, IF APPROVED BY THE PROJECT ARBORIST, MUST FOLLOW THE DESCRIPTION PROVIDED IN THESE REMOVAL NOTES
- IF ROOT PRUNING IS APPROVED WITHIN THE CRR, OR IF THE ROOTS ARE OUTSIDE OF THE CRR, ROOTS MUST BE SEVERED CLEARLY WITH NO JAGGED EDGES, BY A TRENCHEER OR SIMILAR EQUIPMENT, ALIGNED RADICALLY TO THE TREE. THIS METHOD REDUCES THE LATERAL MOVEMENT OF ROOTS AND SUBSTANTIALLY REDUCES SEVERING OF ROOTS BY OTHER MEANS DURING EXCAVATION. THIS IS PARTICULARLY EFFECTIVE WHERE MULTIPLE TREES HAVE INTERTWINING ROOTS. THIS EFFORT SHALL TAKE PLACE PRIOR TO ANY OTHER LAND DISTURBANCE ACTIVITY
- WITHIN FOUR HOURS OF PRUNING, ALL TREE ROOTS THAT HAVE BEEN SEVERED AND/OR DAMAGED SHALL BE TRIMMED CLEARLY AND COVERED WITH MOIST BURLAP OR A FINE-GRADE POLYMER HYDROGEL SLURRY (1000 MICRONS OR LESS) TO PREVENT DESICCATION BEFORE THE PERMANENT COVER CAN BE INSTALLED



NOTE: EXCAVATION TO BE PAID FOR UNDER ITEM #203 02

A NEW TREE WITH PERMEABLE AGGREGATE

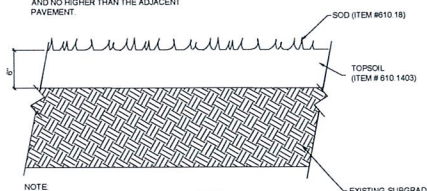


NOTE: EXCAVATION TO BE PAID FOR UNDER ITEM #203 02

B EXISTING TREE, EXISTING SOIL, REMOVAL AND REPLACEMENT WITH STRUCTURAL SOIL

GENERAL NOTES

- SECTIONS ARE TAKEN PARALLEL TO THE CURB
- THE TOP OF SOD SHALL BE NO LOWER THAN 1/2" FROM THE TOP OF ADJACENT PAVEMENT AND NO HIGHER THAN THE ADJACENT PAVEMENT



NOTE: EXCAVATION TO BE PAID FOR UNDER ITEM #203 02

C NEW SOD WITH STRUCTURAL SOIL AND PERMEABLE AGGREGATE

GENERAL NOTES

- SECTIONS ARE TAKEN PARALLEL TO THE CURB
- THE TOP OF SOD SHALL BE NO LOWER THAN 1/2" FROM THE TOP OF ADJACENT PAVEMENT AND NO HIGHER THAN THE ADJACENT PAVEMENT



NOTE: EXCAVATION TO BE PAID FOR UNDER ITEM #203 02

D NEW SOD WITHOUT PERMEABLE AGGREGATE

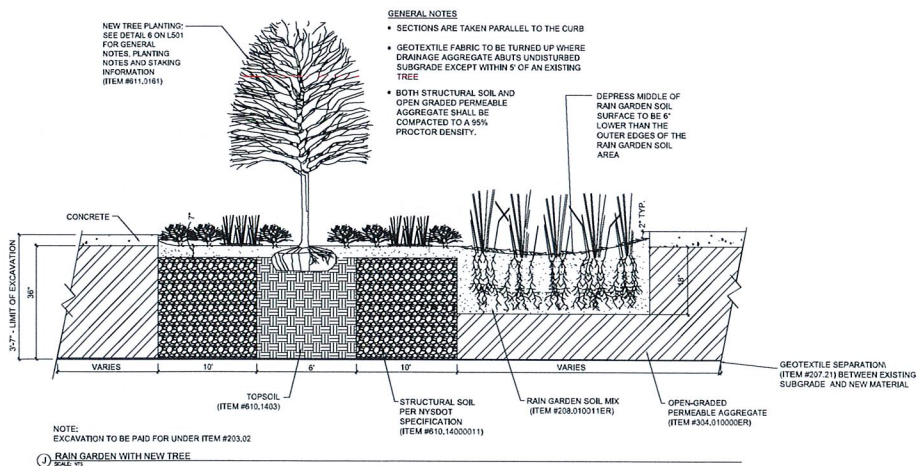
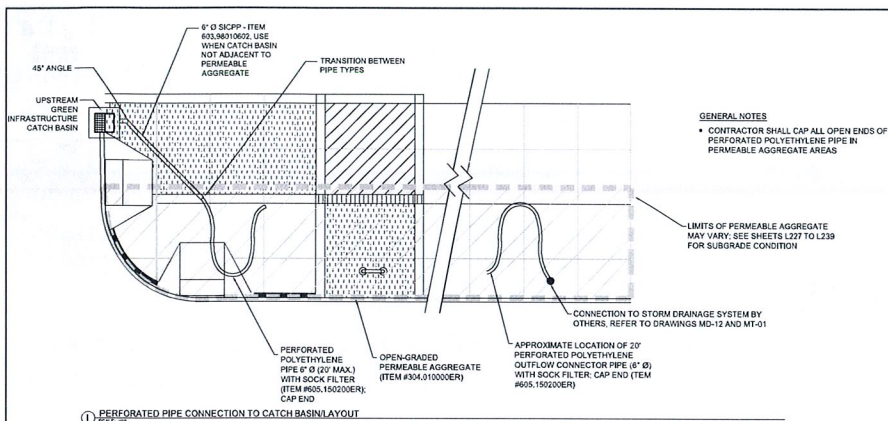
GENERAL NOTES

- SECTIONS ARE TAKEN PARALLEL TO THE CURB
- THE TOP OF SOD SHALL BE NO LOWER THAN 1/2" FROM THE TOP OF ADJACENT PAVEMENT AND NO HIGHER THAN THE ADJACENT PAVEMENT



NOTE: EXCAVATION TO BE PAID FOR UNDER ITEM #203 02

E NEW SOD WITH STRUCTURAL SOIL AND PERMEABLE AGGREGATE



Niagara Street Improvements

Phase II
Virginia St. to Porter Ave.



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REVISIONS				
NO.	DATE	DESCRIPTION	BY	CHECKED
1				



SITE DETAILS

NOTE:
Unexcavated subgrade in addition to this drawing is a violation of the New York State Education Law Article 141, Section 1202

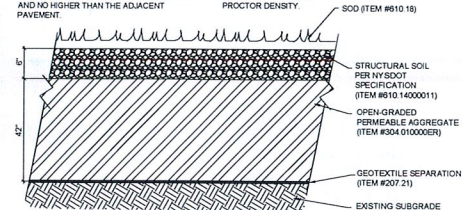
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Design: JKL
Check: JKL
Scale: AS SHOWN
Date: FEBRUARY 2018
By: JKL

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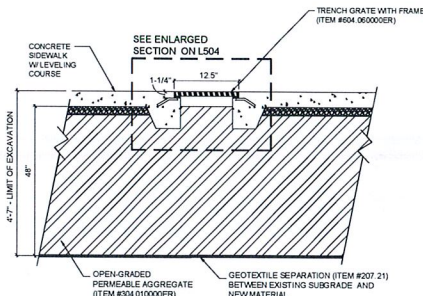
L506
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GENERAL NOTES

- SECTIONS ARE TAKEN PARALLEL TO THE CURB
- THE TOP OF SOD SHALL BE NO LOWER THAN 1/2" FROM THE TOP OF ADJACENT PAVEMENT AND NO HIGHER THAN THE ADJACENT PAVEMENT.
- BOTH STRUCTURAL SOIL AND OPEN GRADED PERMEABLE AGGREGATE SHALL BE COMPACTED TO A 95% PROCTOR DENSITY



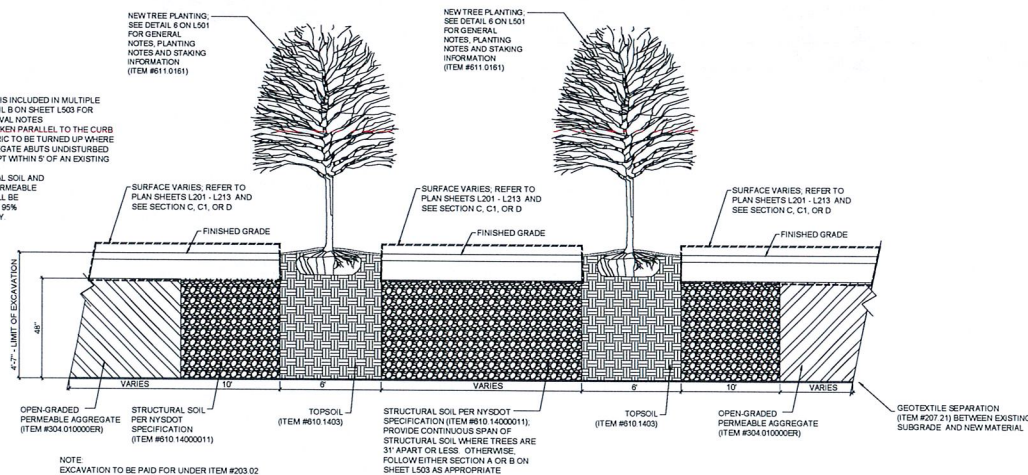
NEW SOD WITH STRUCTURAL SOIL AND PERMEABLE AGGREGATE



TRENCH GRATE / FRAME SYSTEM #604 060000ER

GENERAL NOTES

- IF EXISTING TREE IS INCLUDED IN MULTIPLE TREES, SEE DETAIL 8 ON SHEET L503 FOR SUBGRADE REMOVAL NOTES
- SECTIONS ARE TAKEN PARALLEL TO THE CURB
- GEOTEXTILE FABRIC TO BE TURNED UP WHERE DRAINAGE AGGREGATE ADJUTS UNDISTURBED SUBGRADE EXCEPT WITHIN 5' OF AN EXISTING TREE
- BOTH STRUCTURAL SOIL AND OPEN GRADED PERMEABLE AGGREGATE SHALL BE COMPACTED TO A 95% PROCTOR DENSITY



MULTIPLE TREES IN STRUCTURAL SOIL PIT

Niagara Street Improvements

Phase II
Virginia St. to
Porter Ave.



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REVISIONS			
NO.	DATE	DESCRIPTION	BY / CHKD
1		DATE REVISION	BY / CHECKED



SITE DETAILS

NOTE:
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Project Manager	AK
Designed By	AK
Drawn By	AK/One DCA
Checked By	AK
Date Printed	10/26/2014
Scale	AS SHOWN

Project No. 14-0000

Drawing No. 14-0000

L508
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Appendix E

Green Infrastructure Systems and Landscaping Contract Requirements

MARYLAND TO THE END OF PHASE II

90% RULE (CH. 4: UNIFIED SW SIZING CRITERIA)

$$WQV = [(P)(R_v)(A)]/12$$

$$P = 0.86$$

$$R_v = 0.95 \text{ (ASSUMES 100\% IMPERMEABILITY)}$$

NOTE:

$$1 \text{ ACFT} = 43,560 \text{ CF}$$

• ASSUMES 20%
AVAILABLE PORE-SPACE
IN THE DRAINAGE AREA

* THE PHASE II PORTION IS APPROX. 2/3 OF THE BLOCK.

- DRAINAGE AREA 'A'

$$27,425 \times 0.66 = 18,100.5 \text{ SF}$$

$$= 0.42 \text{ AC}$$

REQ:

$$WQV = [(0.86)(0.95)(0.42)]/12$$

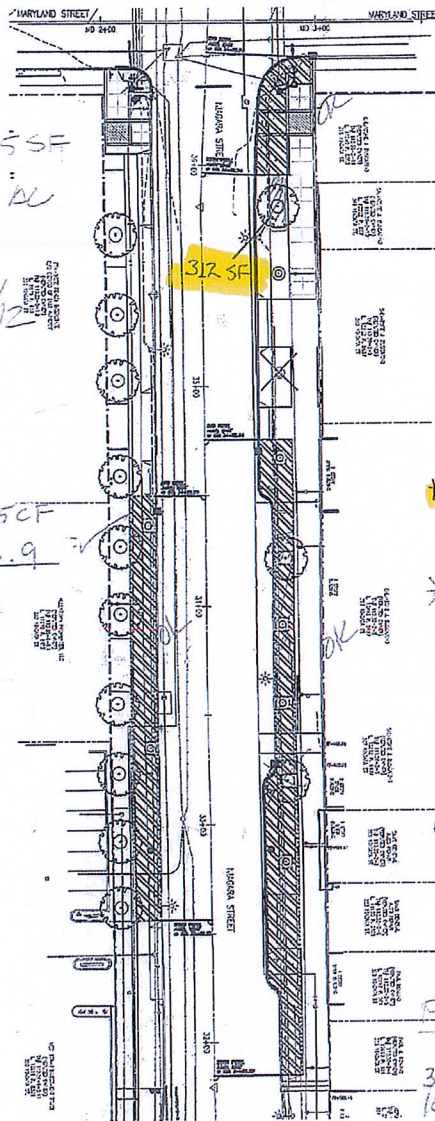
$$= 0.0286 \text{ ACFT}$$

$$= 1,245.82 \text{ CF}$$

PLANNED:

$$2206.5 \text{ SF} \times 3' = 6619.5 \text{ CF}$$

$$6619.5 \text{ CF} \times 0.2 = 1323.9 \text{ CF}$$



- DRAINAGE AREA 'B1'

$$3422 \text{ SF} = 0.079 \text{ AC}$$

$$WQV = [(0.86)(0.95)(0.079)]/12$$

$$= 0.0054 \text{ ACFT}$$

$$= 234.29 \text{ CF REQ.}$$

PLANNED:

$$886.0 \text{ SF} \times 3' = 2658 \text{ CF}$$

$$2658.0 \text{ CF} \times 0.2 = 531.6 \text{ CF} \checkmark$$

$$+ 312(3)(.2) = 187.2 \text{ CF} \quad E = 718.8 \text{ CF}$$

DRAINAGE AREA 'B2'

* AGAIN, OUR PHASE ONLY
IS 2/3 OF THE BLOCK.

$$40,933 \times 0.66 = 27,015.78 \text{ SF}$$

$$= 0.62 \text{ AC}$$

REQ:

$$WQV = [(0.86)(0.95)(0.62)]/12$$

$$= 0.042 \text{ ACFT}$$

$$= 1,838.74 \text{ CF}$$

PLANNED:

$$3571.3 \text{ SF} \times 3' = 10,713.9 \text{ CF}$$

$$10,713.9 \text{ CF} \times 0.2 = 2,142.8 \text{ CF} \checkmark$$

PENNSYLVANIA TO HUDSON

WEST SIDE AREA = 32,645 SF

* ASSUME THAT 1/3 OF THIS AREA DRAINS TO EACH BUMPOUT

$$32,645 \times 0.33 =$$

$$10,772.85 \text{ SF} =$$

$$0.247 \text{ AC}$$

REQ:

$$WQV = [(0.86)(0.95)(0.247)]/12$$

$$= 0.0168 \text{ ACF}$$

$$= 732.53 \text{ CF FOR ALL}$$

3 BUMPOUTS

- DRAINAGE AREA 'A'

PLANNED:

$$1387.0 \text{ SF} \times 3 = 4,161.0 \text{ CF}$$

$$4,161.0 \times 0.2 = 832.2 \text{ CF} \checkmark$$

$$+ 100.8(3)(0.2) = 108.5 \text{ CF}$$

$$\Sigma = 940.7 \text{ CF}$$

- DRAINAGE AREA 'A2'

PLANNED:

$$1402.7 \text{ SF} \times 3 = 4,208.1 \text{ CF}$$

$$4,208.1 \text{ SF} \times 0.2 = 841.62 \text{ CF} \checkmark$$

- DRAINAGE AREA 'A3'

PLANNED:

$$1451.67 \text{ SF} \times 3 = 5,855.0 \text{ CF}$$

$$5,855.0 \text{ CF} \times 0.2 = 1,171 \text{ CF} \checkmark$$

$$+ (117.0 + 1172.6)(3)(0.2) = 777.2 \text{ CF}$$

$$\Sigma = 1948.2 \text{ CF}$$

90% RULE (CH4: UNIFIED
STW SIZING CRITERIA)

$$WQV = [(P)(R)(A)]/12$$

$$P = 0.86$$

$$R = 0.95 \text{ (ASSUMES 100% IMPERMEABILITY)}$$

NOTE:

$$1 \text{ ACF} = 43,560 \text{ CF}$$

• ASSUMES 20% AVAILABLE PORE SPACE IN THE DRAINAGE AGGREGATE.

- DRAINAGE AREA 'B'

REQ:

$$A = 1,841 \text{ SF} = 0.042 \text{ AC}$$

$$WQV = [(0.86)(0.95)(0.042)]/12$$

$$= 0.003 \text{ ACF} = 124.56 \text{ CF}$$

PLANNED:

$$1,312.06 \text{ SF} \times 3 = 3,936.18 \text{ CF}$$

$$3,936.18 \text{ CF} \times 0.2 = 787.24 \text{ CF} \checkmark$$

- DRAINAGE AREA 'B2'

* ASSUME 40% OF THE DRAINAGE AREA FLOWS TO THE MID-BLOCK BUMPOUT.

$$36,174 \times 0.4 = 14,469.6 \text{ SF}$$

$$= 0.33 \text{ AC}$$

REQ:

$$WQV = [(0.86)(0.95)(0.33)]/12$$

$$= 0.022 \text{ ACF} = 976.66 \text{ CF}$$

PLANNED:

$$1,749.42 \text{ SF} \times 3 = 5,248.26 \text{ CF}$$

$$5,248.26 \text{ CF} \times 0.2 = 1,049.65 \text{ CF} \checkmark$$

- DRAINAGE AREA 'B3'

* ASSUMES 60% OF THE DRAINAGE FLOWS TO THE FINAL BUMPOUT.

REQ:

$$36,174 \times 0.6 = 21,704.4 \text{ SF}$$

$$= 0.50 \text{ AC}$$

$$WQV = [(0.86)(0.95)(0.50)]/12$$

$$= 0.034 \text{ ACF} = 1481.04 \text{ CF}$$

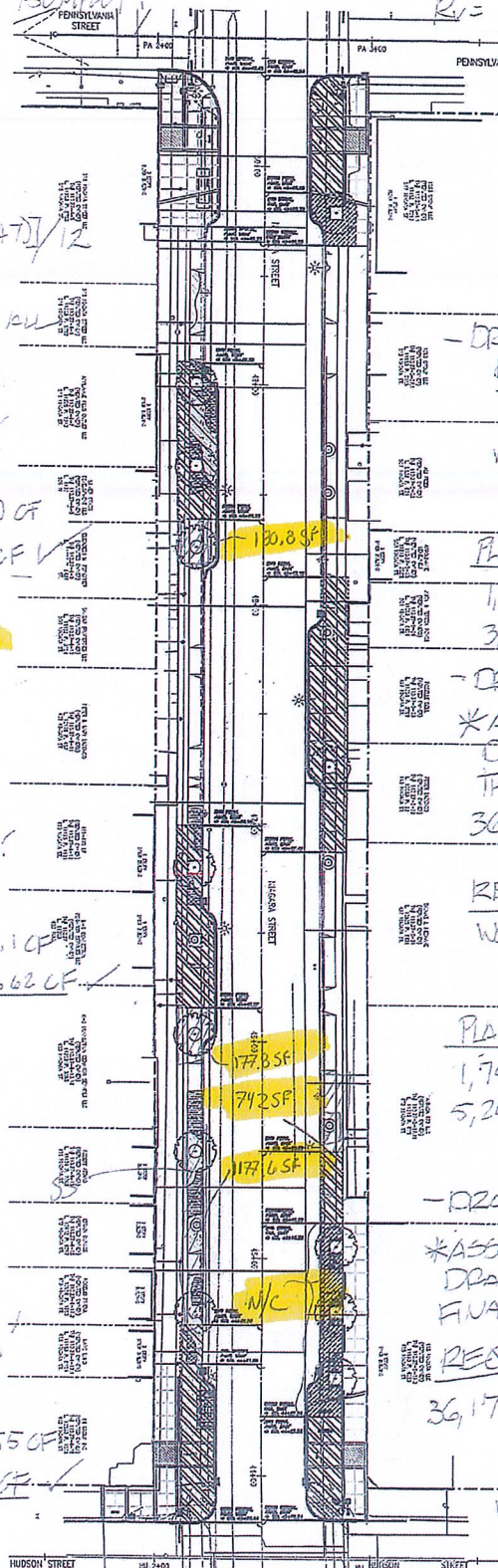
PLANNED:

$$2584.3 \text{ SF} \times 3 = 7752.9 \text{ CF}$$

$$7752.9 \text{ CF} \times 0.2 = 1550.58 \text{ CF} \checkmark$$

$$+ (712)(3)(0.2) = 445 \text{ CF}$$

$$\Sigma = 1995.8 \text{ CF}$$



90% RULE (CH. 4: UNIFIED SIZING CRITERIA)

$$P = 0.96$$

$R_v = 0.95$ (ASSUMED
100% IMPERVIOUSNESS)

• 1 ACFT = 43 560 CF

- ASSUMES 20% AVAILABLE PORE SPACE IN THE DRAINAGE AGGREGATES

* ASSUME 40% DRAINS TO THE MID-BLOCK BUMBOOT.

$$31,635 \times 0,4 = 12,654 \text{ SF}$$
$$= 0,29 \text{ Ad}$$

$$W_{eqv} = [(0.86)(0.95)(0.29)] / 1.2$$

$$= 0.0197 \text{ ACF} = 860.05 \text{ CF}$$
$$1.700,75 \times 3 = 5.102,1 \text{ CF}$$

$$5,102.1 \times 0.2 = \underline{1,020.42 \text{ CF}}$$

$$+ (312 + 312)(3)(0.2) = 374.4 \text{ CF} \quad \Sigma = 1394.8 \text{ CF}$$

* 60% OF THE DRAINAGE

AREA DRAINS TO THE LAST
BUMP OUT. $31,635 \times 0.6 = 18,981 \text{ SF}$
 $= 0.43 \text{ AC}$

$$WQV = [(0.86)(0.95)(0.43)]/12$$

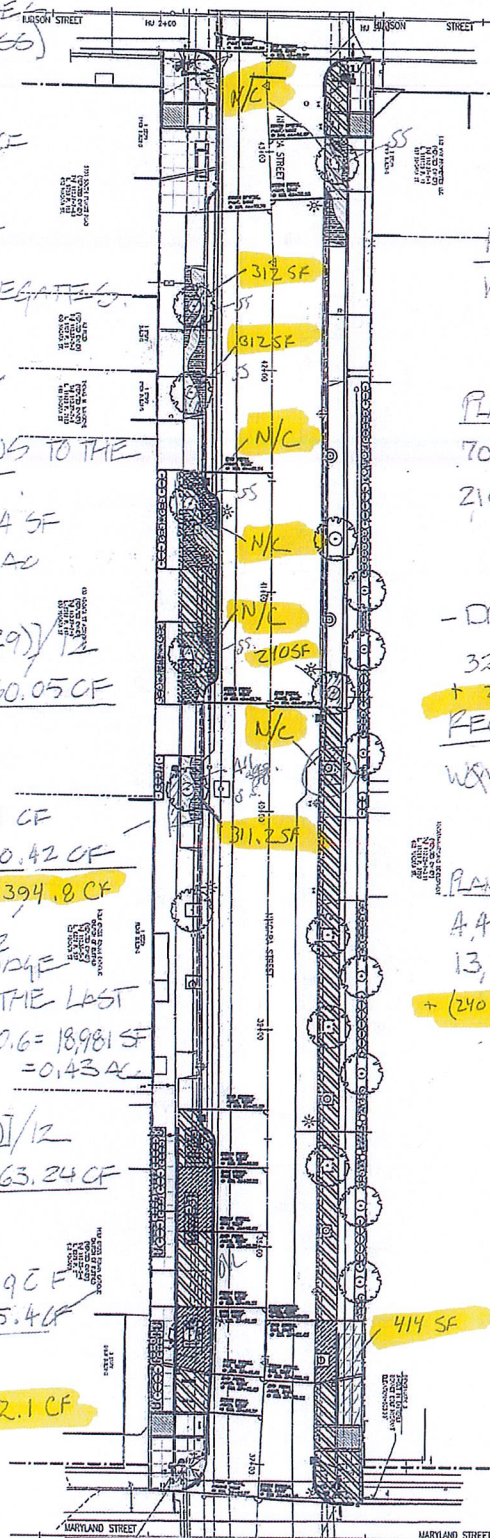
$$= 0.02920 \text{ CF} = \underline{1263.24 \text{ CF}}$$
$$2392.35F \times 3 = 7176.9CF$$

$$7.176.96 \times 0.2 = \underline{1,435.46}$$

$$+ (311.2)(3)(0.2) = 186.7 \text{ CR}$$

$$\Sigma = 1622.1 \text{ CF}$$

AREAS CHANGE FROM
OPEN AGGREGATE TO
STRUCTURAL SOIL
NO CHANGE TO VOL
CALCULATIONS



- DESIGN AREA 'B'
2,606 SF = 0.06 AC

$$\begin{aligned} \text{Req:} \\ w_{qv} &= [(0.86)(0.95)(0.06)]/12 \\ &= 0.004 \text{ ACFT} = 174.24 \text{ CF} \end{aligned}$$
$$702.88 \text{ CF} \times 3' = 2108.64 \text{ CF}$$

$$2100 \cdot 64 \text{ CF} \times 0.2 = 421.7 \text{ CF}$$

$$32,219 \text{ f} = 0.74 \text{ AC}$$

+ 2449 SF 0.80 AC

$$WQV = [(0.86)(0.95)(0.74)] / 12$$

$$= 0.054 CF = \frac{2194.62 CF}{2372.6 CF}$$
$$A 459,69F \times 3 = 13,578,8 CF$$

$$13,378.8 \times 0.2 = \underline{2,675.8 \text{ CFV}}$$

$$+ (240 + 414)(3)(0.2) = 392.4$$

$$\Sigma = 3068.2 \text{ CF}$$

JERSEY TO PENNSYLVANIA

90% RULE (CH. 4: UNIFIED STU SIZING CRITERIA)

$$WQV = [(P)(R_v)(A)]/12$$

$$P = 0.86$$

$$R_v = 0.95 \text{ (ASSUMES 100\% IMPERVIOUSNESS)}$$

NOTE:

- 1 ACF = 43,560 CF
- ASSUMES 30% AVAILABLE PORE SPACE IN THE DRAINAGE AGGREGATE

- DRAINAGE AREA 'A'

* ASSUME 40% OF THE DRAINAGE AREA FLOWS TO THE MIDBLOCK BUMPOUT
 $34,241 \times 0.4 = 13,696.4 \text{ SF}$
 $= 0.31 \text{ AC}$

REQ:

$$WQV = [(0.86)(0.95)(0.31)]/12$$

$$= 0.0211 \text{ ACF}$$

$$= 919.12 \text{ CF}$$

PLANNED:

$$1788 \text{ SF} \times 3' = 5,364 \text{ CF}$$

$$5,364 \times 0.2 = 1,072.8 \text{ CF}$$

$$1,072.8(3)(0.2) = 641.4 \text{ CF} \quad \Sigma = 1,714.2 \text{ CF}$$

- DRAINAGE AREA 'A2'

* REMAINING 60% OF THE DRAINAGE FLOWS TO THE NEXT BUMPOUT
 $34,241 \times 0.6 = 20,544.6 \text{ SF}$
 $= 0.47 \text{ AC}$

REQ:

$$WQV = [(0.86)(0.95)(0.47)]/12$$

$$= 0.032 \text{ ACF}$$

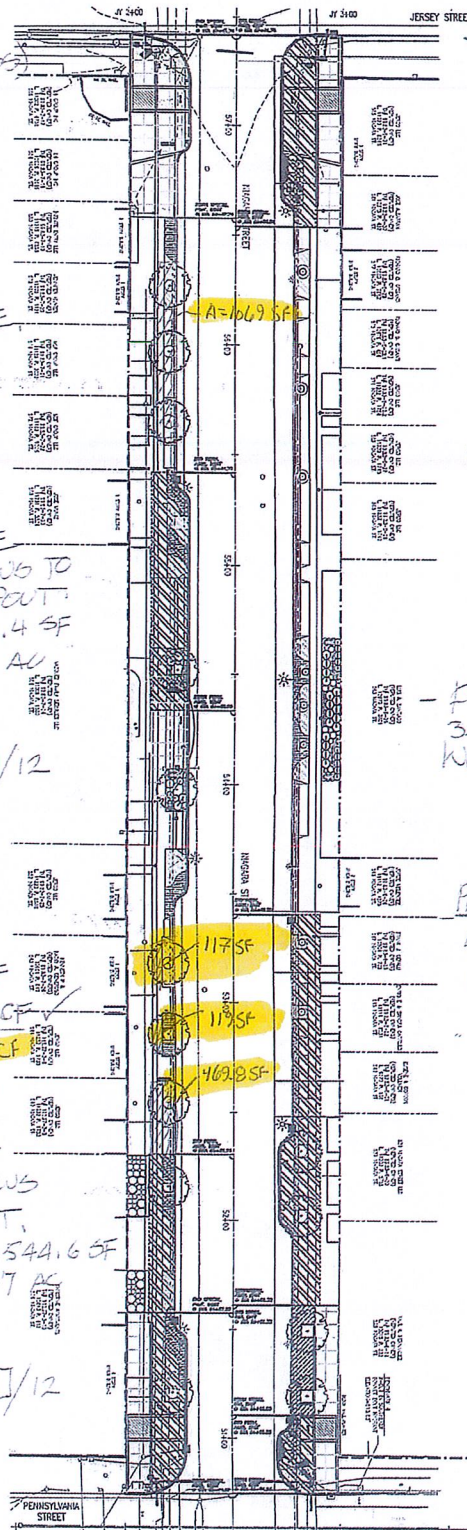
$$= 1,393.92 \text{ CF}$$

PLANNED:

$$2,342.3 \text{ SF} \times 3' = 7,176.9 \text{ CF}$$

$$7,176.9 \text{ CF} \times 0.2 = 1,435.4 \text{ CF}$$

$$(117 + 119 + 469.8)(3)(0.2) = 423.4 \quad \Sigma = 1,858.8 \text{ CF}$$



- DRAINAGE AREA 'B'

REQ:

$$2,237 \text{ SF} = 0.051 \text{ AC}$$

$$WQV = [(0.86)(0.95)(0.051)]/12$$

$$= 0.003 \text{ ACF}$$

$$= 151.25 \text{ CF}$$

PLANNED:

$$1,409.77 \text{ SF} \times 3' = 4,229.31 \text{ CF}$$

$$4,229.31 \text{ CF} \times 0.2 = 845.9 \text{ CF}$$

- DRAINAGE AREA 'B2'

$$34,458 \text{ SF} = 0.79 \text{ AC}$$

$$WQV = [(0.86)(0.95)(0.79)]/12$$

$$= 0.054 \text{ ACF}$$

$$= 2,342.91 \text{ CF} \quad \text{REQ}$$

PLANNED

$$4,899.5 \text{ SF} \times 3' = 14,698.5 \text{ CF}$$

$$14,698.5 \text{ CF} \times 0.2 = 2,939.7 \text{ CF}$$

WATER TO - JERSEY

90% RULE (CH. 4.1 UNIFIED STW SIZING CRITERIA)

$$WQV = [(P)(R)(A)]/12$$

P = 90% RAINFALL EVENT (SEE FIG. 4.1)

$$= \pm 0.86 \text{ IN BUFFALO}$$

$$R_v = 0.05 + (0.009)(I)$$

* ASSUME 100% IMPERVIOUS SURFACES... EVEN THE TREE AREAS TODAY ARE COMPACTED IN THE R.O.W., SO THAT I = 100%

$$R_v = 0.95$$

NOTE:

- AC-FT = 43,560 CF
- PORE SPACE AVAILABLE IN DRAINAGE AGGREGATE RANGES FROM 20% TO 25%. WE WILL ASSUME ONLY 20% AVAILABLE PORE SPACE.

- DRAINAGE AREA 'A1'

* ASSUMES THAT THE MID-BLOCK BUMP-OUT RECEIVES RUNOFF FROM 1/2 OF THE DRAINAGE AREA:

$$25,544 \text{ SF} / 2 = 12,772 \text{ SF} \\ = 0.29 \text{ AC}$$

REQ:

$$WQV = [(0.86)(0.95)(0.29)]/12 \\ = 0.020 \text{ AC-FT} = 871.2 \text{ CF}$$

PLANNED:

$$1471.6 \text{ CF} \times 3 = 4414.8 \text{ CF} \\ 4414.8 \times 0.2 = 883.0 \checkmark$$

- DRAINAGE AREA 'A2'

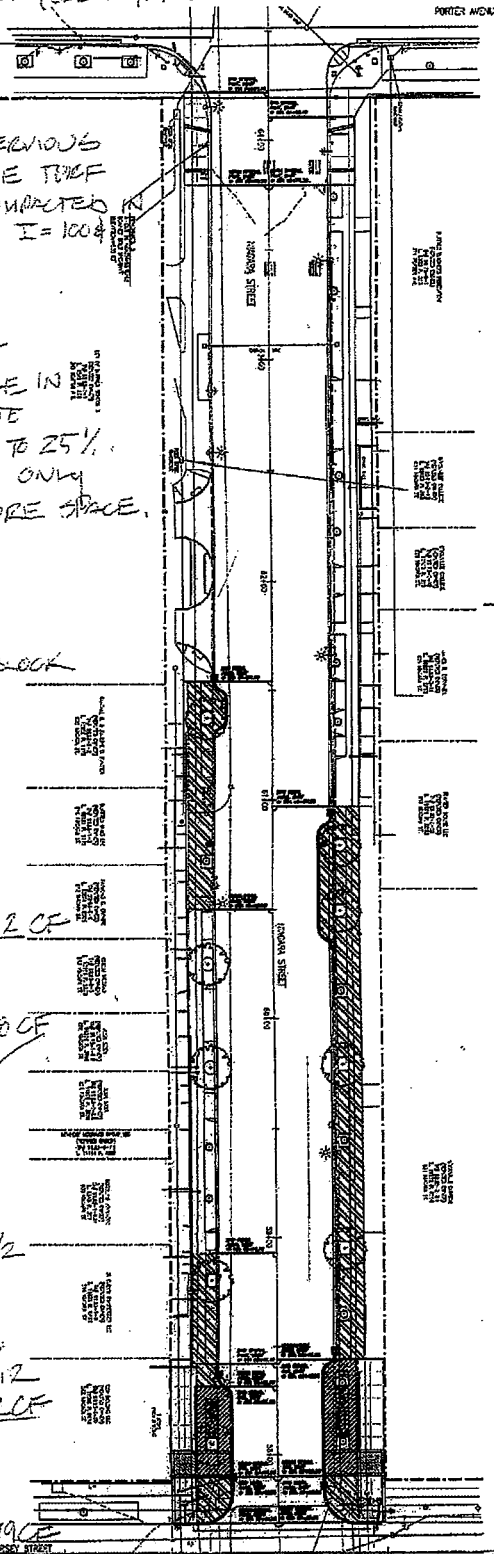
* RECEIVES THE OTHER 1/2 OF THE RUNOFF

REQ:

$$WQV = [(0.86)(0.95)(0.29)]/12 \\ = 0.020 \text{ AC-FT} = 871.2 \text{ CF}$$

PLANNED:

$$1715.93 \text{ SF} \times 3 = 5147.79 \text{ CF} \\ 5147.79 \times 0.2 = 1029.56 \text{ CF} \checkmark$$



- DRAINAGE AREA 'B1'
35,797 SF = 0.82 AC

REQ:

$$WQV = [(0.86)(0.95)(0.82)]/12 \\ = 0.0558 \text{ AC-FT} \\ = 2,431.9 \text{ CF}$$

PLANNED:

$$4622 \text{ SF} \times 3 = 13,866 \text{ CF} \\ 13,866 \times 0.2 = 2773.2 \text{ CF} \checkmark$$

Stormwater
Storage Area Sizing
Calculations

- ☐ Weed planting beds as needed

OCTOBER 16 - NOVEMBER 30

- ☐ Document and photograph any potential hazards to public safety or welfare
- ☐ Document and photograph any instances of erosion or of standing water
- ☐ Remove trash, sediment and debris from all surface storm water conveyance features as needed (including but not limited to gutters, inlets, grates, trench drains and dissipaters)
- ☐ Remove litter and dead plant material from planting beds and all other surface features
- ☐ Re-contour any planting bed areas that have been disturbed or scoured by erosion
- ☐ Remove spent blooms from flowering shrubs and perennials
- ☐ Mow turf grasses on a weekly basis, or as necessary
- ☐ Water planting beds as needed, depending on weather
- ☐ Weed planting beds as needed

JUNE 1 - JULY 31

- ☐ Document and photograph any potential hazards to public safety or welfare
- ☐ Document and photograph any instances of erosion or of standing water
- ☐ Remove trash, sediment and debris from all surface storm water conveyance features as needed (including but not limited to gutters, inlets, grates, trench drains and dissipaters)
- ☐ Remove litter and dead plant material from planting beds and all other surface features
- ☐ Re-contour any planting bed areas that have been disturbed or scoured by erosion
- ☐ Remove spent blooms from flowering shrubs and perennials
- ☐ Inspect plants and trees for disease and address as needed (pesticide and herbicide use is prohibited)
- ☐ Mow turf grasses on a weekly basis, or as necessary
- ☐ Water planting beds as needed, depending on weather
- ☐ Weed planting beds as needed

AUGUST 1 - AUGUST 31

- ☐ Document and photograph any potential hazards to public safety or welfare
- ☐ Document and photograph any instances of erosion or of standing water
- ☐ Remove trash, sediment and debris from all surface storm water conveyance features as needed (including but not limited to gutters, inlets, grates, trench drains and dissipaters)
- ☐ Remove litter and dead plant material from planting beds and all other surface features
- ☐ Re-contour any planting bed areas that have been disturbed or scoured by erosion
- ☐ Remove spent blooms from flowering shrubs and perennials
- ☐ Inspect plants and trees for disease and treat as needed
- ☐ Mow turf grasses on a weekly basis, or as necessary
- ☐ Water planting beds as needed, depending on weather
- ☐ Weed planting beds as needed
- ☐ Remove sediment and debris from inlets and catch basins (once annually)

SEPTEMBER 1 - OCTOBER 15

- ☐ Document and photograph any potential hazards to public safety or welfare
- ☐ Document and photograph any instances of erosion or of standing water
- ☐ Remove trash, sediment and debris from all surface storm water conveyance features as needed (including but not limited to gutters, inlets, grates, trench drains and dissipaters)
- ☐ Remove litter and dead plant material from planting beds and all other surface features
- ☐ Re-contour any planting bed areas that have been disturbed or scoured by erosion
- ☐ Remove spent blooms from flowering shrubs and perennials
- ☐ Mow turf grasses on a weekly basis, or as necessary
- ☐ Water planting beds as needed, depending on weather

Landscape Maintenance Checklist:

APRIL 1 - APRIL 15

- ☐ Document and photograph any potential hazards to public safety or welfare
- ☐ Document and photograph any instances of erosion or of standing water in all planting areas
- ☐ Remove trash, sediment and debris from all surface storm water conveyance features as needed (including but not limited to gutters, inlets, grates, trench drains and dissipaters)
- ☐ Remove litter and dead plant material from planting beds and all other surface features
- ☐ Re-contour any planting bed areas that have been disturbed or scoured by erosion
- ☐ Procure seed for top-seeding and patching turf grass as necessary
- ☐ Procure mulch for planting beds
- ☐ Cut dormant ornamental grasses to 8" from soil line
- ☐ Prune trees and woody plants while still dormant as necessary to maintain public safety and plant condition
- ☐ Mow turf grasses on a weekly basis, or as necessary
- ☐ Water planting beds as needed, depending on weather
- ☐ Weed planting beds as needed

APRIL 16 - MAY 31

- ☐ Document and photograph any potential hazards to public safety or welfare
- ☐ Document and photograph any instances of erosion or of standing water in all planting areas
- ☐ Remove trash, sediment and debris from all surface storm water conveyance features as needed (including but not limited to gutters, inlets, grates, trench drains and dissipaters)
- ☐ Remove litter and dead plant material from planting beds and all other surface features
- ☐ Re-contour any planting bed areas that have been disturbed or scoured by erosion
- ☐ Assess planting beds referencing the planting plan and a plant identification manual to identify individual plants that have not survived
- ☐ Procure and plant replacement plants for those that have not survived
- ☐ Top-seed and patch turf grass as needed
- ☐ Top off planting beds with at least 1" of new mulch, adding more in areas where it has been depleted to ensure that all mulched areas are a minimum of 3" thick
- ☐ Inspect plants and trees for disease and treat as needed
- ☐ Mow turf grasses on a weekly basis, or as necessary
- ☐ Water planting beds as needed, depending on weather
- ☐ Weed planting beds as needed

the Preliminary Maintenance Walkthrough Punchlist can serve as the Final Maintenance Punchlist. At that time the BSA representative will schedule a final maintenance walkthrough with the Contractor. If deficiencies still exist, they must be corrected by the Contractor. After the acceptance of the Final Maintenance Walkthrough Punchlist, as prepared by the BSA representative, the Maintenance period by the Contractor is complete.

2. The Maintenance Bond will be held by the BSA representative until BSA certifies that all maintenance work defined under this section has been satisfactorily completed. When the Contractor satisfactorily completes the work, the bond will be returned. No partial releases of funds will be made.

1. Maintain plantings by pruning dead plant material as needed, cultivating, watering, weeding, fertilizing, mulching, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as often as needed to establish healthy, viable plantings. Maintain three inch depth of mulch around all trees and in all landscape and groundcover areas. **Pesticides and herbicide use is prohibited in City of Buffalo rights-of-way.**
 - a. Use integrated pest management practices whenever possible to minimize and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
 - b. Avoid spraying water into the roadway or onto private property. Do not allow water to puddle on pavement or turf areas.
2. Cut back ornamental grasses and all *Liriope* during the first maintenance period in the spring.

During the final inspection period at the end of the two-year maintenance period, the Contractor shall remove nursery tags, stakes, gator bags, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and project site.

B. Turf maintenance:

1. Neither pesticides nor herbicides are allowed in the City of Buffalo rights-of-way.
2. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
3. Water turf with fine spray at a minimum rate of one inch per week unless rainfall precipitation is adequate.
4. Mow lawns as soon as there is enough top growth to cut the grass to the height below. Repeat mowing as required to maintain the height specified below. Remove no more than 40 percent of grass leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Time initial and subsequent mowings to maintain following grass height:
 - a. Mow grass from 2 inches to 2-1/2 inches high. Do not mow to less than 2 inches.
 - b. Pick-up of grass clippings shall be required during or immediately after each mowing, if clippings are an average of 1 inch or longer in length.
5. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.
 - a. Use fertilizer that will provide actual nitrogen of at least 1 lbs./1000 sq. ft. to turf area.

C. Preliminary and Final Maintenance Walkthrough:

1. The Contractor shall schedule a preliminary walkthrough with the designated BSA representative to occur during the final inspection period at the end of the two-year maintenance period. At the time of the preliminary maintenance walkthrough, all necessary plant replacements have occurred and all routine maintenance activities have been completed by the Contractor. Any deficiencies noted in the Preliminary Maintenance Walkthrough Punchlist (prepared by the BSA representative) shall be corrected by the Contractor. If no deficiencies were noted by the Buffalo Sewer Authority representative,

Inspection of the landscape plants and sod by the Contactor shall occur no less than six times during each growing season. The Contractor shall submit a completed inspection checklist, within five business days from the end of the inspection period, to the designated BSA representative, who will be identified at the time of final project acceptance following the construction phase. A copy of this checklist is included at the end of this document. Please note that the required maintenance activities listed above must be performed as-needed and may need to occur multiple times during any maintenance period. The Contractor shall note all specific landscape plant, sod, or groundcover issues encountered, the locations where problems were observed, and the corrective measures used to address the problems. Pictorial documentation of these issues also is required to be submitted. Routine maintenance activities performed by the Contractor shall be listed on the form with the dates they were performed. Periodic review of the completed inspection forms will occur prior to the processing of payment requests by the Contractor. The minimum required inspection periods are listed below:

1. Insp. Period 1: Apr. 1 to Apr. 15
 2. Insp. Period 2: Apr. 16 to May 31
 3. Insp. Period 3: June 1 to July 31
 4. Insp. Period 4: Aug. 1 to Aug. 31
 5. Insp. Period 5: Sept. 1 to Oct. 15
 6. Insp. Period 6: Oct. 16 to Nov. 30
- P. Thriving landscape plants will be evidenced by the presence of new live plant shoots arising from at least 95 percent of its branching (if a tree or shrub) or two-thirds of the clump (if a perennial or ornamental grass).
- Q. Thriving sod will be evidenced by stands of green grass, free of weeds and with no bare spots.
- R. Make plant replacements under the guarantee as required during the period of June 1 to September 15. Replace plants prior to the next landscape inspection. Replacement plants shall be of the exact genus, species, and size as indicated in the project plant list. No substitutions are allowed during the guarantee period without the prior permission of the Landscape Architect. Any plants that die during a season unfavorable for planting must be replaced during the first month of the following favorable planting season.
- S. During maintenance activities, the Contractor shall keep adjacent pavement and turf clean and in an orderly condition, and all adjacent sidewalks passable.
- T. All removed landscape plants, sod, and groundcover shall be disposed of properly by the Contractor according to local codes.
- U. The Contractor is solely responsible for the expenses of all repairs and replacement to public and private property damaged during maintenance activities. The Contractor shall notify the designated BSA contact immediately upon recognition that the damage has occurred. The Contractor shall not undertake repairs or replacements to damaged property unless directed to do so by the BSA contact. The contact information for the Buffalo Sewer Authority representative will be provided during by the time of final project acceptance following the construction phase.

3.2 EXECUTION OF LANDSCAPE MAINTENANCE ACTIVITIES

- A. Tree, shrub, ornamental grass, and groundcover plant maintenance:

- I. Period of Guarantee and Maintenance: Guarantee all trees, shrubs, ornamental grasses, perennials, and sod for a minimum of two years for these plantings to become established and to achieve a vigorous growing condition from final acceptance at the end of Construction Contract until the end of the Guarantee and Maintenance Period. Maintain trees, shrubs, sod, and other plants throughout each required maintenance inspection period through the end of the guarantee period.
- J. Maintain trees, shrubs, and other plants by pruning, watering, fertilizing, mulching, removing dead foliage, and weeding as required for healthy growth and an attractive streetscape. Restore planting saucers. Tighten and repair stake and guy supports and reset trees and shrubs to proper grades or vertical position as required. Maintain and fill the gator bags with water for the new trees. Remove all debris and trash from planting areas. Maintain as required to keep trees and shrubs free of insects and disease. Dead or diseased plants shall be replaced by the Contractor. Each landscape plant area, including the mulched areas around trees, shall be free of weeds and undesirable grasses throughout the guarantee period.
- K. Maintain groundcover areas (consisting of *Liriope spicata* or species of *Sedum*) by watering, fertilizing, mulching, and weeding as required until a full, dense mass of groundcover is achieved, with no gaps between plants greater than six square inches after one full growing season, except where utility covers or other man-made structures occur. At the end of the second growing season, no gaps greater than three square inches should be visible, except where utility covers or other man-made structures occur. Dead or diseased plants shall be replaced by the Contractor in order to meet the required density of groundcover. Each groundcover area shall be free of weeds and undesirable grasses at the end of the guarantee period.
- L. Maintain sodded areas by watering, spot weeding, fertilizing, mowing, repatching dead areas with new sod of the exact same species, and the removal of trash and debris, as required until a full, uniform stand of turf, free of weeds, undesirable grass species, disease, and pests, with no bare spots exceeding a 3-inch by 3-inch area, is achieved and accepted at the end of the guarantee period. Dead or diseased portions of sod shall be replaced by the Contractor.
- M. All plant replacements shall be the Contractor's sole expense except for replacements resulting from:
 - 1. vandalism
 - 2. snow plowing and snow removal operations
 - 3. proven animal damage
 - 4. subsequent utility and construction work
- N. Water will not be available along the project corridor; the Contractor shall provide all water required to ensure tree, landscape plant, and turf vigor.
- O. All maintenance work must be performed by personnel with current landscape contractor licenses from the City of Buffalo.

open-graded permeable aggregate or structural soil into the underdrain and drainage structure overflow system.

2. One representative location shall be tested to ensure proper functioning of the green infrastructure system. The selected location will be determined in the field by the Resident Engineer. Contractor shall provide sufficient water quantities to ensure adequate saturation of the permeable layer to produce an overflow situation. Drainage inlets and/or the nearest downstream manhole shall be observed for water infiltration resulting from the test. If testing results reveal poor infiltration of excess water into the overflow system, the subgrade shall be removed and reinstalled until the required results are obtained at no additional cost to the Contract.
3. Costs for testing the green infrastructure system shall be paid under Item 304.01000010 Open-Graded Permeable Aggregate and Item 610.14000011 Structural Soil.

PART THREE - EXECUTION

3.1 MAINTENANCE OF LANDSCAPING

- A. The Contractor agrees to manage and maintain the properties professionally and in good faith and shall ensure that it will maintain prompt and courteous service to the public. The Contractor must provide an Operations Manager to act as single point of communication with the BSA.
- B. The Contractor shall provide and properly supervise all personnel required to safely maintain each property. A staffing plan must be submitted with each proposal.
- C. The Contractor shall be responsible for the maintenance indicated. The BSA reserves the right to perform routine property inspections, to insure proper maintenance is being performed. The BSA reserves the right to direct Contractor's maintenance and specific repairs.
- D. The BSA reserves the right to alter and delete tasks listed above as per available funding and at the discretion of the General Manager during contract performance. Decisions may be informed by site conditions and weather.
- E. The Contractor shall communicate and coordinate maintenance with community volunteer groups and neighbors that perform planting bed maintenance or tree plantings in designated properties.
- F. The Contractor shall be responsible for security of employees and equipment.
- G. Acts of theft or vandalism shall be reported to the Commissioner of Public Works, Parks and Streets within 24 hours of discovery.
- H. The Contractor shall be responsible for providing and maintaining all equipment needed to complete their work.

The contractor shall use its good faith efforts to achieve the utilization of minority group members, women and other disadvantaged workforce members consistent the City of Buffalo Code § 96-13 (F); Article 15A of NYS Executive Law; and federal Equal Employment Opportunity and Disadvantaged Business Enterprise laws, where applicable.

- E. Living and/or Prevailing Wage. BSA contractors are required to execute an Affirmation of Understanding and Agreement that they will comply with the City of Buffalo Living Wage provisions, contained City of Buffalo Code § 96-19; NYS Prevailing Wage law; and the Davis Bacon Act, where applicable.
- F. Residency. In support of City of Buffalo Code § 96-17, the Landscape Contractor agrees that (i) in the hiring of any employees, subcontractor(s), or person(s) acting on behalf of the subcontractor, preference shall first be given to qualified persons who have resided in the City of Buffalo for at least six (6) consecutive months immediately prior to the commencement of their employment for the performance of work, and, (ii) the Landscape Contractor and any subcontractor(s) will work towards ensuring a minimum residency goal of 25% of workforce to include qualified residents in the City of Buffalo. Landscape Contractors shall report residency on the provided Equal Employment Opportunity Staffing Plan.

PART TWO - TESTING

2.1 SYSTEM TESTING

- A. Permeability of the Drainage Aggregates Testing:
 - 1. The Contractor shall test the permeability of permeable aggregate and structural soil in four sample locations for each material. The Contractor shall conduct the test in the following manner after compaction is complete:
 - a. Pour a gallon of water through a 2-inch diameter pipe held ½-inch above the aggregate surface.
 - b. Measure the diameter in which the water spreads across the surface of the compacted aggregate bed. Highly permeable bases should not allow water to spread more than 20 inches before it infiltrates through the material.
 - c. This test will be conducted with the Resident Engineer present.
 - d. The test report shall note the specific location of each test and the maximum diameter of the spread of water.
 - e. If testing results reveal excessive spread, the permeable bases will be removed and reinstalled until the required results are obtained at no additional cost to the Contract.
 - f. Costs for testing the permeable base material shall be paid under Item 610.14000011 Structural Soil.
- B. Testing of Green Infrastructure:
 - 1. Once all special aggregate subbase layers have been placed to their proper depths and compaction densities, and all sock-filtered underdrain pipe has been installed and connected to their respective drainage structures, the green infrastructure system shall be tested prior to placement of any final top surfaces. The testing is to ensure the free-flow of water from the

GREEN INFRASTRUCTURE SYSTEMS AND LANDSCAPING

PART ONE - CONTRACT

1.1 CONSTRUCTION CONTRACT REQUIREMENTS

- A. The installation of landscaping features including all growing media, mulch, trees, shrubs, ornamental grasses, perennials, groundcover, and sod shall be performed by a Landscape Contractor licensed to do business in the City of Buffalo. The successful bidder on this project must provide proof of being licensed as a City of Buffalo Landscape Contractor to execute the contract and maintain said license throughout the project.
- B. The installation of Green Infrastructure elements as detailed in the contract documents shall be subject to a Performance Bond in the value of 100% of the full contract bid price excluding any Add Alternates included in the Bid Documents. All applicable aspects of Article 111 shall apply as detailed to all aspects of the proper work including the Green Infrastructure Systems and Landscaping.
- C. The Performance Bond shall specifically identify the City of Buffalo and the Buffalo Sewer Authority (BSA) as additionally insured parties and shall stay in force until final acceptance of the Construction Contract by the City of Buffalo.

1.2 MAINTENANCE CONTRACT REQUIREMENTS

- A. The licensed Landscape Contractor who installed all landscaping will be expected to enter into a Maintenance Contract with the BSA to provide maintenance of all landscaping features placed under the Construction Contract. This Maintenance Contract will have a period of two (2) years from the date of Construction Contract acceptance.
- B. The licensed Landscape Contractor shall submit a bid cost to supply the detailed maintenance and guarantee landscaping in accordance with the requirements in Section 3.1 for the duration of the Guarantee and Maintenance Period. Progress payments should be issued to the licensed Landscape Contractor in accordance with the Inspections Periods listed below.
- C. A Maintenance Bond would be provided by the licensed City of Buffalo Landscape Contractor for the growing media, mulch and establishment of trees, shrubs, ornamental grasses, perennials, groundcover, and sod through the end of said Guarantee and Maintenance Period. The bond value shall equal the green infrastructure maintenance contract amount. At the successful conclusion and acceptance of the Maintenance Contract, the Maintenance Bond would be released.
- D. Workforce Diversity. The BSA encourages our contracting partners to adopt business methods and models that foster and result in a diverse workforce, with at least 30% participation for minority and 30% participation for women. The Landscape Contractor shall provide a copy of their Equal Employment Opportunity Policy (EEO) and complete the provided Equal Employment Opportunity Staffing Plan.



Niagara Street

Rain Garden Care & Maintenance Guide



Appendix F

Niagara Street Rain Garden Care & Maintenance Guide

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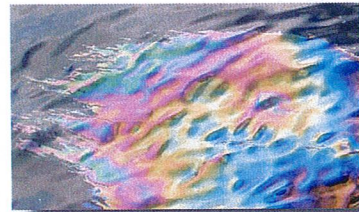
Getting to Know Your Rain Garden

The Reason for Rain Gardens

All around the nation, cities are starting to build more and more rain gardens into streets, sidewalks, and public spaces. What is a rain garden and why are they helpful?

Think about it this way: before Buffalo was a city, the area we live in was mostly covered in forests and meadows. When it rained (or when snow melted) most of that water would be absorbed into the thick layer of soil that blankets the ground. Very slowly, it would percolate through the ground, getting filtered along the way until it finally reached underground aquifers or found its way into local creeks, rivers, and lakes.

In a city, storm water follows a very different path. It lands on many hard surfaces that can't absorb water, such as rooftops, roads, parking lots and sidewalks. The water flows across these surfaces and into the underground storm sewer system that sends the water directly into local streams, rivers, and lakes. This works great to prevent flooding, but it also causes a few unintended problems.



Pollution: Contaminants on the ground such as fertilizers, pesticides, oils, car fluids, soaps and pet waste get washed into our waterways. This can harm fish and wildlife, and make the water unsafe for people



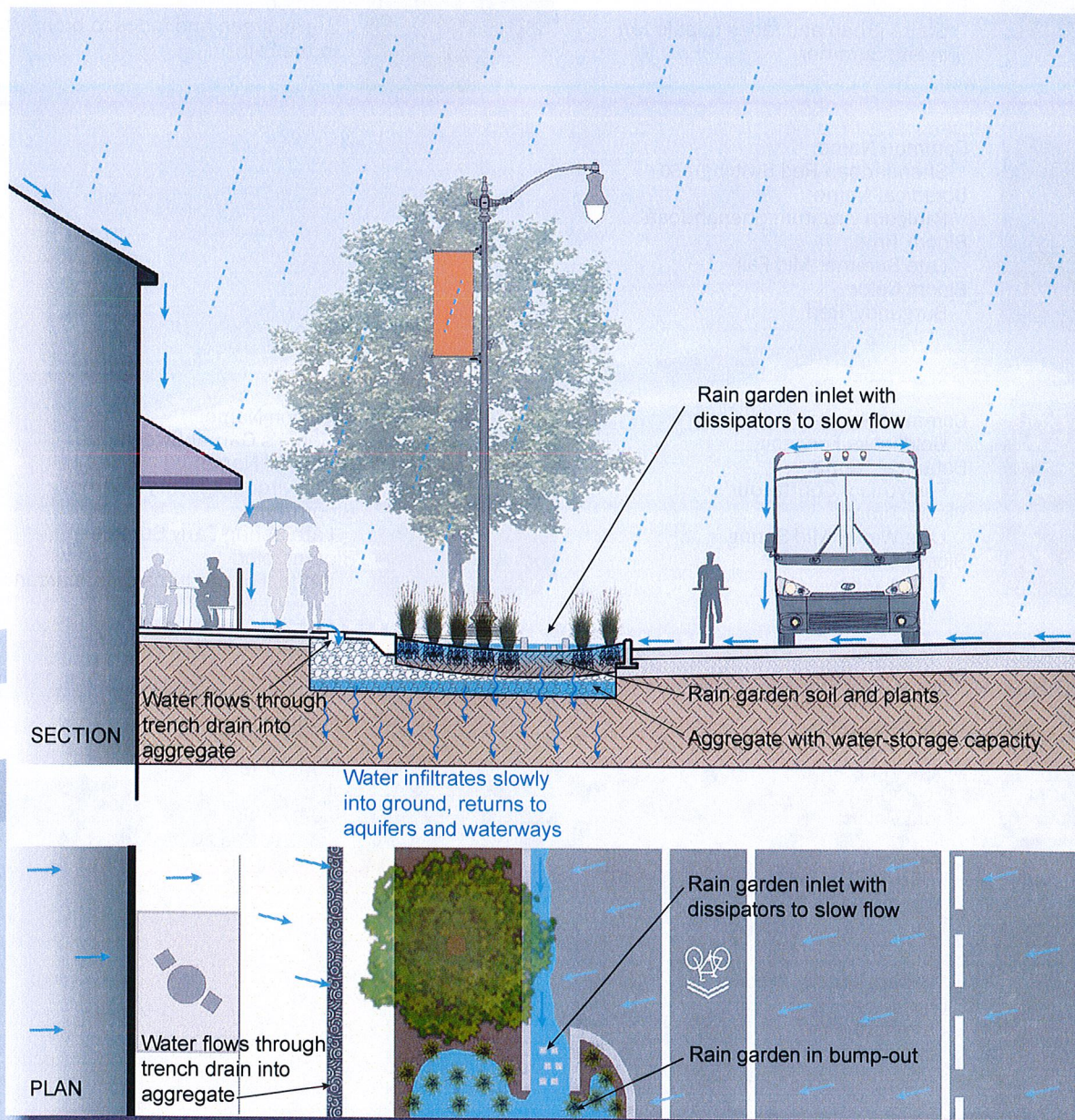
Erosion: During heavy storms, water is channeled into the stream so quickly that it can cause erosion of streams and river banks. This erosion can destroy important habitat for fish and other wildlife.



Getting to Know Your Rain Garden

How Does a Rain Garden Work?

Your rain garden is part of the solution! The rain garden adjacent your property is designed to take in a portion of storm water and hold onto it for a while. It is full of a specially engineered soil mix that will filter out pollutants and allow the water to slowly absorb into the ground, the way nature intended. The plants in your rain garden have been selected to be able to thrive when partially submerged, but also survive when it's dry. Your rain garden improves the water quality by slowing the water's journey to local waterways AND making sure it arrives cleaner. That's an important job... and it looks beautiful while doing it.



Getting to Know Your Rain Garden

The Plants

The following are the plants you will find in Niagara Street Rain Gardens. They have been selected for their ability to survive in the specific conditions of an in-street rain garden.

Ornamental Grasses



Common Name:
Overdam Reed Grass
Botanical Name:
Calamagrostis x acutiflora 'Overdam'
Bloom Time:
Late Spring-Early Summer
Bloom Color:
Starts green and fades to pale tan
in late Summer



Common Name:
Northern Sea Oats
Botanical Name:
Chasmanthium latifolia
Bloom Time:
Mid Summer-Early Fall
Bloom Color:
Starts green and fades to bronze/tan
in the Fall



Common Name:
Shenandoah Red Switchgrass
Botanical Name:
Panicum virgatum 'Shenandoah'
Bloom Time:
Late Summer-Mid Fall
Bloom Color:
Burgundy/Red

Shrubs



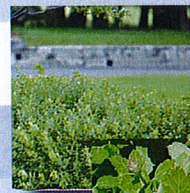
Common Name:
Goldilocks Forsythia
Botanical Name:
Forsythia x 'Courtacour'
Bloom Time:
Late Winter-Mid Spring
Bloom Color:
Bright Yellow



Common Name:
Henry's Garnet Sweetspire
Botanical Name:
Itea virginica 'Henry's Garnet'
Bloom Time:
Late Spring-Early Summer
Bloom Color:
White, Foliage turns dark maroon in Fall



Common Name:
Sea Green Juniper
Botanical Name:
Juniperus Chinensis 'Sea Green'
Bloom Time:
Evergreen
Bloom Color:
None



Common Name:
Gro-Low Sumac
Botanical Name:
Rhus aromatic 'Gro-Low'
Bloom Time:
Mid Spring
Bloom Color:
Pale Yellow, Foliage turns bright red in
Fall



Common Name:
Midnight Wine Weigela
Botanical Name:
Weigela florida 'Elvera'
Bloom Time:
Late Spring-Early Summer
Bloom Color:
Pink, with burgundy foliage



Getting to Know Your Rain Garden

The Plants, Continued...

Perennials



Common Name:
Lucifer Crocosmia
Botanical Name:
Crocosmia x 'Lucifer'
Bloom Time:
Mid Summer
Bloom Color:
Bright Red



Common Name:
Caesar's Brother Siberian Iris
Botanical Name:
Iris sibirica 'Caesar's Brother'
Bloom Time:
Late Spring-Early Summer
Bloom Color:
Purple and White



Common Name:
Big Blue Lily Turf
Botanical Name:
Liriope muscari 'Big Blue'
Bloom Time:
Late Summer-Early Fall
Bloom Color:
Violet/Lavender



Common Name:
Creeping Lily Turf
Botanical Name:
Liriope spicata
Bloom Time:
Late Summer-Early Fall
Bloom Color:
Violet/Lavender



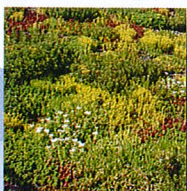
Common Name:
Walker's Low Catmint
Botanical Name:
Nepeta x faassenii 'Walker's Low'
Bloom Time:
Late Spring-Mid Fall
Bloom Color:
Blue-Violet



Common Name:
Little Spire Russian Sage
Botanical Name:
Perovskia atriplicifolia 'Little Spire'
Bloom Time:
Late Spring-Early Fall
Bloom Color:
Blue-Violet



Common Name:
Fireworks Goldenrod
Botanical Name:
Solidago rugose 'Fireworks'
Bloom Time:
Late Summer-Early Fall
Bloom Color:
Gold (Yellow-Orange)



Common Name:
Assorted Stonecrop
Botanical Name:
Sedum, Assorted
Bloom Time:
Varies
Bloom Color:
Varies (Yellow, White, Pink, Red)



Getting to Know Your Rain Garden

The Weeds

Weeds are nothing more than a wild plant growing where it is not wanted. They can rob the plants you're trying to grow of the nutrients and root space they need to thrive. Maintaining a 3" thick layer of shredded wood mulch will help limit the number of weeds that take root in your garden... but no matter what you do, there will always be unwanted weeds that sprout in your garden.

In a rain garden, pulling weeds out by hand is the only way to control them without compromising the function of the garden. Never apply herbicide to your rain garden! Weeds can have deep and aggressive roots so it's important to remove as much of the root as possible. Always grasp the weed from the very base, near the soil surface, and pull directly up. For stubborn weeds, it may be helpful to dig the whole thing out, roots and all, using your trowel.

To pull or not to pull? Since there are hundreds of kinds of weeds found in our region, the best way to avoid pulling a desirable plant is to get to know them. A full list of "friendly" plants can be found on pages 4 and 5. Once you are familiar with them, you can assume everything else is a weed. Below are some of the most common weeds.



Common Name:
Red Clover
Botanical Name:
Trifolium pretense



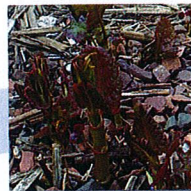
Common Name:
White Clover
Botanical Name:
Trifolium repens



Common Name:
Dandelion
Botanical Name:
Taraxacum



Common Name:
Broadleaf Plantain
Botanical Name:
Plantago major



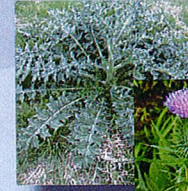
Common Name:
Japanese Knotweed
Botanical Name:
Fallopia japonica



Common Name:
Lamb's Quarters
Botanical Name:
Chenopodium berlandieri



Common Name:
Tree of Heaven
Botanical Name:
Ailanthus altissima



Common Name:
Bull Thistle / Spear Thistle
Botanical Name:
Cirsium vulgare



Common Name:
Garlic Mustard
Botanical Name:
Alliaria petiolate



Common Name:
Wild Carrot / Queen Anne's Lace
Botanical Name:
Daucus carota



Caring for Your Rain Garden

Safety First

Caring for your rain garden will require you to be in the public right-of-way. Here are a few safety concerns you'll want to keep in mind:



Ensure you are visible to traffic; wear brightly colored clothing and only work on your rain garden during daylight hours.



Be aware of the locations of vehicles, cyclists, pedestrians and pets at all times.



Keep supplies and tools out of the path of travel of vehicles, cyclists and pedestrians.



Anything that lands on the street or sidewalk could wash into your rain garden. Some of these objects could be sharp or dangerous to handle. Proceed with caution when removing and handling debris to avoid injury.



Dispose of any medical waste or hypodermic needles found in your rain garden using methods that are approved for medical waste.



Never handle dead animal carcasses without gloves or grabbers. Double bag any carcass and dispose of in an appropriate garbage facility.



Wildlife or insects (such as rodents or bees) could be present in your rain garden. Proceed with caution to avoid surprise encounters.



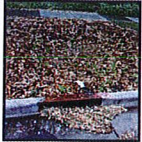
Caring for Your Rain Garden

Equipment



Monthly Care

The following tasks should be performed monthly, and after each heavy rain storm.



Remove trash or debris (including tree and leaf litter) from the rain garden and any inlets.



Sweep Inlets



If rainwater has carved a channel or displaced soil in your garden contact RainCheck to request maintenance.



Always ensure that there is a 3" cover of shredded hardwood mulch in your rain garden. If the storm has disturbed it, redistribute to achieve a uniform thickness. Only use shredded hardwood mulch in your rain garden as wood chip mulches tend to float and wash away.

Editor's Note: Images above to be replaced with new images photographed after project construction is complete

Seasonal Care

Here are a few tasks to perform during each specific season.

SPRING



1. If water is ponding in garden or inlet for more than 48 hours, contact RainCheck to request maintenance.
2. Cut all ornamental grasses to 6" tall.
3. Remove weeds.
4. Top-off shredded hardwood mulch as needed to achieve uniform 3" thick cover.
5. Remove Trash

SUMMER



1. If water is ponding in garden or inlet for more than 48 hours, contact RainCheck to request maintenance.
2. Remove weeds.
3. Water garden if any plants begin to wilt during extended drought or high temperatures.
4. Identify any plants that have died and notify Raincheck to request replacement.
5. Remove Trash

WINTER



1. If water is ponding in garden or inlet for more than 48 hours, contact RainCheck to request maintenance.
2. Remove leaf litter.
3. Clear snow & ice from inlets. (No need to remove snow from garden).
4. Remove Trash

FALL



1. If water is ponding in garden or inlet for more than 48 hours, contact RainCheck to request maintenance.
2. Remove weeds.
3. Remove leaf litter.
4. Allow dried ornamental grass foliage to remain throughout the winter.
5. Remove Trash



Caring for Your Rain Garden

Personalizing Your Garden

It's normal to want to add your own personal touch to the look of your garden. There's definitely room for that, but there are a few things to consider so the garden can continue to function properly.

Plants

The plants in your rain garden have been specially selected to be able to thrive in these specific conditions. Not all plants are able to withstand the extremes of inundation, drought, and road salt. It is not recommended to remove any of these plants or to introduce new species. If you discover that one of these plants has died, contact RainCheck to arrange for replacement. It is possible to add your own personal touch by adding spring bulbs to your rain garden, but it is recommended that they be planted near the edges where they will be less likely to be exposed to excessive moisture.

Rocks and Statuary

Adding heavy objects like rocks and statuary to your rain garden could compress the soil and reduce its ability to take in water. Keep this in mind if adding ornamental objects to your garden. It's best to keep heavy items to a minimum.

Soil

The soil in your rain garden is a specially engineered mix designed to provide just the right amount of nutrients to the plants, while still allowing water to flow through at the desired rate. Adding ordinary soil, peat, sand or other growing media to your rain garden could stop the rain garden from functioning properly. If you need to add any new soil to your rain garden, contact RainCheck.

Fertilizer

Do not add fertilizer to your rain garden. It can wash through the soil and add to pollution in local waterways. The specially designed soil mix in your rain garden has all of the nutrients required to keep the plants healthy. Additionally, the natural decomposition of the mulch layer in your rain garden will provide a continuous source of renewed nutrients.



Caring for Your Rain Garden

Troubleshooting

Ponding

It is normal to find standing water in your rain garden immediately after a storm, but it should drain through within 24-48 hours. If water is ponding or backing up for more than two days, contact RainCheck to request maintenance.

Erosion

If the flow of rain water has carved deep channels or displaced your soil, contact RainCheck to request maintenance.

Dead Plants

If spring is coming to an end and you've noticed that one or more plants in your garden is dead, contact RainCheck to request maintenance.

Pest Management

If you notice that any of your plants are being damaged by insects or other pests, contact RainCheck to request maintenance. DO NOT apply pesticide to your rain garden.



CONTACT INFORMATION:
WEBSITE: raincheckbuffalo.org
EMAIL: raincheck@sa.ci.buffalo.ny.us
TELEPHONE: 716-851-4664 x 4254



our **people** and our **passion** in every **project**

 **Bergmann**
associates
architects // engineers // planners

May 12, 2015

Mr. John Bidell
Associate Engineer
Department of Public Works
City Hall, Room 515
Buffalo, New York 14202

RE: Niagara Street Improvements Phase II
Stormwater Capture Report

Dear Mr. Bidell:

We are transmitting two (2) copies of the Stormwater Capture Report for the subject project area for your review and comment. In addition, we will send one (1) additional copy to Buffalo Sewer Authority for their concurrent review and use as requested.

Should you have any questions and/or comments to be addressed, please contact me at (716) 852-3211, Ext. 864.

Sincerely,

Bergmann Associates



Kelly M. Thompson, P.E.
Business Segment Leader – Traffic Operations & ITS Services

Enclosures

cc: T. Duk, City of Buffalo DPW w/attachment
J. O'Neill, Buffalo Sewer Authority w/attachment



